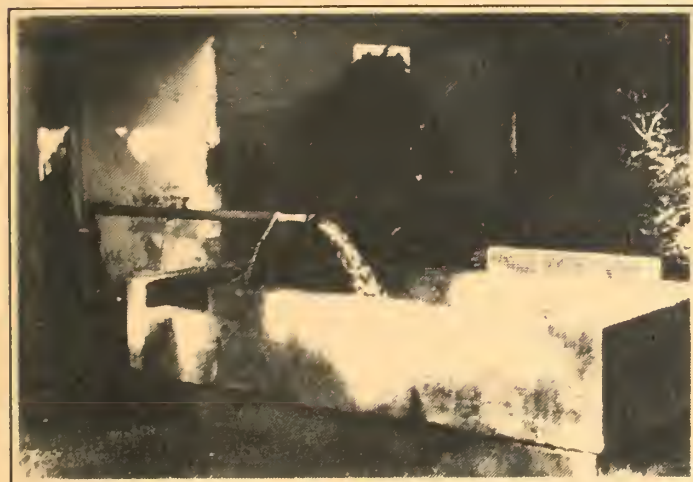


# Ground-water resources of northern Vermilion County, Illinois

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Prepared in cooperation with  
the Illinois Department of Transportation,  
Division of Water Resources

Illinois Department of Energy and Natural Resources  
STATE GEOLOGICAL SURVEY DIVISION  
Jack A. Simon, Chief

ENVIRONMENTAL GEOLOGY NOTES 101  
OCTOBER 1981

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# Contents

- ABSTRACT 1
- ACKNOWLEDGMENTS 1
- INTRODUCTION 2
  - Purpose of study 2
  - Geography of the study area 3
- STRATIGRAPHY OF THE AREA 3
  - Geologic framework 3
  - Bedrock geology 7
  - Bedrock topography and drift thickness 7
  - Glacial drift units 10
- DISTRIBUTION OF AQUIFERS 10
  - Banner Formation, Mahomet Sand Member 10
  - Glasford Formation outwash 15
  - Surficial sand and gravel aquifers 15
- PUBLIC WATER SUPPLIES 21
  - Hoopeston 21
  - Rossville 25
  - Potomac 25
  - Rankin 26
  - Bismarck 27
  - Armstrong and Henning 27
- GEOPHYSICAL STUDY 27
- SUMMARY OF AQUIFER CONDITIONS 33
- REFERENCES 35

## **TABLES**

1.	Hoopeston wells and aquifer characteristics	23
2.	Rossville wells and aquifer characteristics	25
3.	Potomac wells and aquifer characteristics	26

## **FIGURES**

1.	Map showing physiographic provinces	4
2.	Surficial geology of northern Vermilion County (from Lineback, 1979)	5
3.	Bedrock geology and generalized stratigraphic column	6
4.	Bedrock topography of northern Vermilion County	8
5.	Drift thickness of northern Vermilion County	9
6.	Generalized stratigraphic column of glacial drift in northern Vermilion County	11
7a.	Elevation of the top of the Mahomet Sand in northern Vermilion County	12
7b.	Thickness of the Mahomet Sand in northern Vermilion County	13
8.	Depth to the top of the Mahomet Sand in northern Vermilion County	14
9a.	Elevation of the top of the Glasford outwash in northern Vermilion County	16
9b.	Thickness of the Glasford outwash in northern Vermilion County	17
10.	Depth to the top of the Glasford outwash and occurrence of the Henry Formation (patterned area) in northern Vermilion County	18
11.	North-south cross section from north of East Lynn to south of Potomac	20
12.	East-west cross section three miles south of Route 9	21
13.	East-west cross section about two miles north of Route 136	22
14.	North-south cross section through Hoopeston	24
15.	Basic elements of an earth resistivity meter and the Wenner electrode configuration	28
16.	Apparent resistivity curve and layering parameters determined by Zohdy Inversion Technique	29
17.	Slice map, "true" resistivity at 500-ft elevation	31
18.	Slice map, "true" resistivity at 600-ft elevation	32
19.	Approximate ranges of electrical resistivity for rocks and soils	33
20.	Summary of aquifer conditions in northern Vermilion County	34



# Ground-water resources of northern Vermilion County, Illinois

## ABSTRACT

*Increasing water needs for the city of Danville and cancellation of plans for a new reservoir on the Middle Fork of the Vermilion River have led to renewed interest in the ground-water resources of northern Vermilion County. The thick glacial drift in the area contains two extensive sand and gravel aquifer systems: the upper system is an outwash at the base of the Glasford Formation (Illinoian); the lower is the Mahomet Sand Member of the Banner Formation (pre-Illinoian). The latter aquifer occupies the Mahomet Bedrock Valley and its tributaries. Both of these aquifers are extensively utilized by farms, municipalities, and industries throughout the area.*

*Maps have been prepared to show different aspects of the geology of the study area, including drift thickness, bedrock surface elevation, and the thickness, areal extent, and depth of the Glasford outwash and Mahomet Sand.*

*An extensive electrical earth resistivity survey was run throughout the study area to supplement available geologic information. The interpretation of these vertical electrical sounding (VES) data is presented in the form of resistivity slice maps, which are useful in delineating new areas to be tested for future ground-water resources. Areas of relatively large resistivity values correlate well with areas in which coarse-grained aquifer materials are known to exist.*

*Findings of this study should be of interest to state and local governments, planning agencies, and private land owners.*

## ACKNOWLEDGMENTS

This report was partly supported under contract through the University of Illinois by the Department of Transportation, Division of Water Resources, Frank Kudrna, Director. Donald R. Vonnahme and John Carlisle were the project managers.

The authors thank Dr. W. Hilton Johnson of the Department of Geology, University of Illinois, for providing the preliminary stack-unit map of glacial drift units of Vermilion County, and reviewing the discussion of drift stratigraphy in this paper; the Indiana Geological Survey for providing a preliminary bedrock surface map of western Indiana and geologic data for correlating the location of the Mahomet Bedrock Valley between Illinois and Indiana; and Illinois State Geological Survey staff members, Ross Brower, Robert H. Gilkeson, Henry Harris, Cathy Hunt, David Lindorff, Walter Morse, Kemal Piskin, Philip Reed, Barbara Roby, and Susan Wickham, for assisting in the collection of the field electrical resistivity data in the fall of 1978.

## INTRODUCTION

### Purpose of study

This study was initiated by the Illinois Division of Water Resources when it became apparent that the projected water use for the city of Danville would exceed the capacity of its reservoir, Lake Vermilion. Originally, alternative plans called for the construction of a second reservoir on the Middle Fork of the Vermilion River, several miles to the west of the present reservoir. When these plans were canceled, the state helped the city of Danville investigate alternative water sources. An initial study was funded by the Illinois Department of Transportation through the Division of Water Resources. This study resulted in an unpublished report by the Illinois State Water Survey (Singh, 1978) that outlined a number of possible alternatives to the Middle Fork Reservoir. The following suggestions were among the ideas proposed: (1) raise the dam and spillway on Lake Vermilion by as much as 5 ft (1.5 m); (2) dredge accumulated sediment from Lake Vermilion; (3) raise the lake level by 3 to 5 ft (1 to 1.5 m) and employ one or two dredges to remove sediment from the lake; (4) obtain water from the Vermilion River 2 miles (3.2 km) to the south and pipe it north to the water treatment plant; (5) drill wells along the Wabash River northwest of Covington, Indiana, and pump it to Danville; (6) drill wells within the city of Danville; and (7) develop well fields in the northern part of Vermilion County, and either pipe the water directly to Danville or pump it into the North Fork and let it flow downstream into Lake Vermilion.

The plan calling for well fields in the northern part of the county was determined to be the most cost effective, and a study of northern Vermilion County was initiated as a three-phase program. Phase I was a geological and geophysical study to map the Mahomet and Danville Bedrock Valleys and determine the best sites for test drilling. Phase II was to have been an exploration phase in which a number of test holes were to be drilled. Phase III was to have been the drilling of test wells and production testing. Phases II and III and the stratigraphic test drilling for the first phase were never carried out because of opposition to the exporting of ground water from northern Vermilion County.

The geologic setting of northern Vermilion County dictates that moderate-to-large ground-water supplies must come from sand and gravel aquifers in the glacial drift. The glacial deposits are thickest (up to 400 ft [122 m]) in that part of the county, and thick, extensive sand and gravel deposits have been presumed to exist there. Previously, shallow (less than 200 ft [61 m]) sand and gravel aquifers have produced ground-water supplies adequate to meet the demands in the past, so little deeper exploration has been undertaken. Until recently, only sparse data have been available on the topography of the bedrock surface or the occurrence, distribution, and character of sand and gravel aquifers that might be contained within bedrock valleys incised in that surface.

Using available data, we revised maps of bedrock topography and drift thickness and produced maps of the areal extent, depth to, and thickness of sand and gravel deposits; we also produced horizontal slice maps based on field resistivity data. All available driller's logs, sample set studies, commercial



downhole geophysical logs, seismic refraction data, and casing records were used in compiling these maps and in delineating known and potential areas of sand and gravel accumulations.

The presence of the buried Mahomet Bedrock Valley in the northernmost part of the county suggests that deeper sand and gravel aquifers may occur there. The Danville Bedrock Valley, a tributary extending southward through the middle of the study area, has also been thought to contain extensive sand and gravel aquifers. The deepest parts of these valleys are about 350 ft (107 m) above mean sea level. Land surface elevation averages 700 ft (213 m).

## Geography of the study area

*Location and extent of study area.* The study area includes the northern three tiers of townships (T. 21-23 N., R. 10-14 W.), in Vermilion County in eastern Illinois (fig. 1), an area of approximately 380 square miles (973 km<sup>2</sup>). Hoopes-ton, in the northeast corner, is the largest town in the area. Other towns and villages include Rossville, Potomac, Rankin, Alvin, East Lynn, Armstrong, Bismarck, and Henning.

*Physiography and drainage.* The study area lies within the Bloomington Ridged Plain of the Till Plain Section, Central Lowland Province (fig. 1). The surface of the area is marked by a series of arcuate, partly discontinuous glacial moraines oriented east-west across the northern two-thirds of the study area (fig. 2). Parts of another moraine occupy the southeastern and southwestern corners of the area. The northernmost moraine, the Chatsworth, divides drainage between the northern and southern portions of the study area. South of the Chatsworth Moraine, the natural surface drainage is generally to the south and southeast along the Middle Fork and North Fork Rivers and their tributaries.

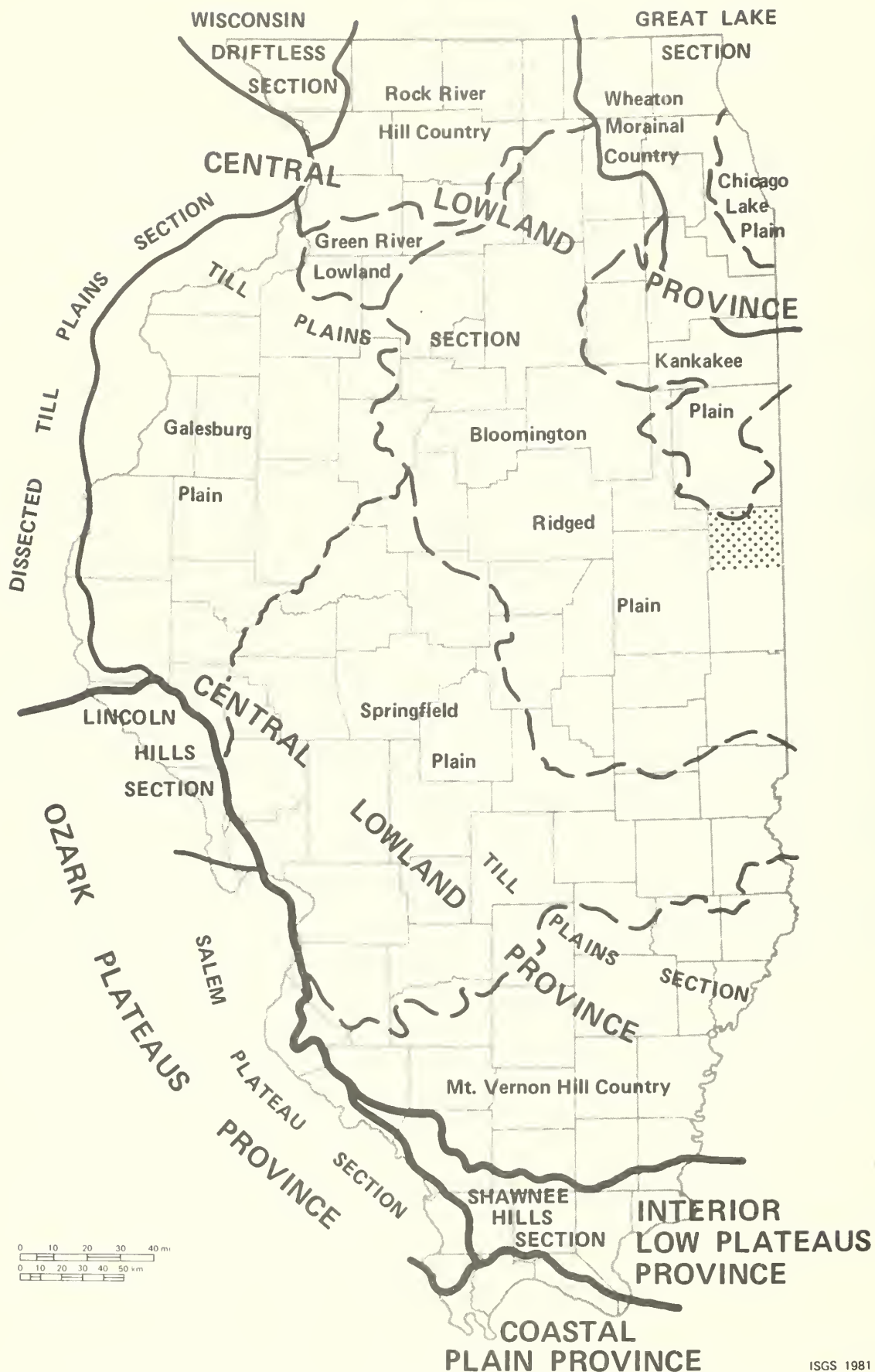
The highest surface elevation, 780 ft (238 m) above sea level, is on the crest of the Chatsworth Moraine 6 to 8 miles (10 to 13 km) north of Potomac. The lowest surface elevation is about 600 ft (183 m) where the North Fork River leaves the area south of Bismarck, for a total relief of about 180 ft (55 m).

Records on file at the Illinois State Water Survey show that the mean annual precipitation in the study area is nearly 37 inches, with monthly averages ranging from about 1.9 inches in February to about 4.4 inches in June.

## STRATIGRAPHY OF THE AREA

### Geologic framework

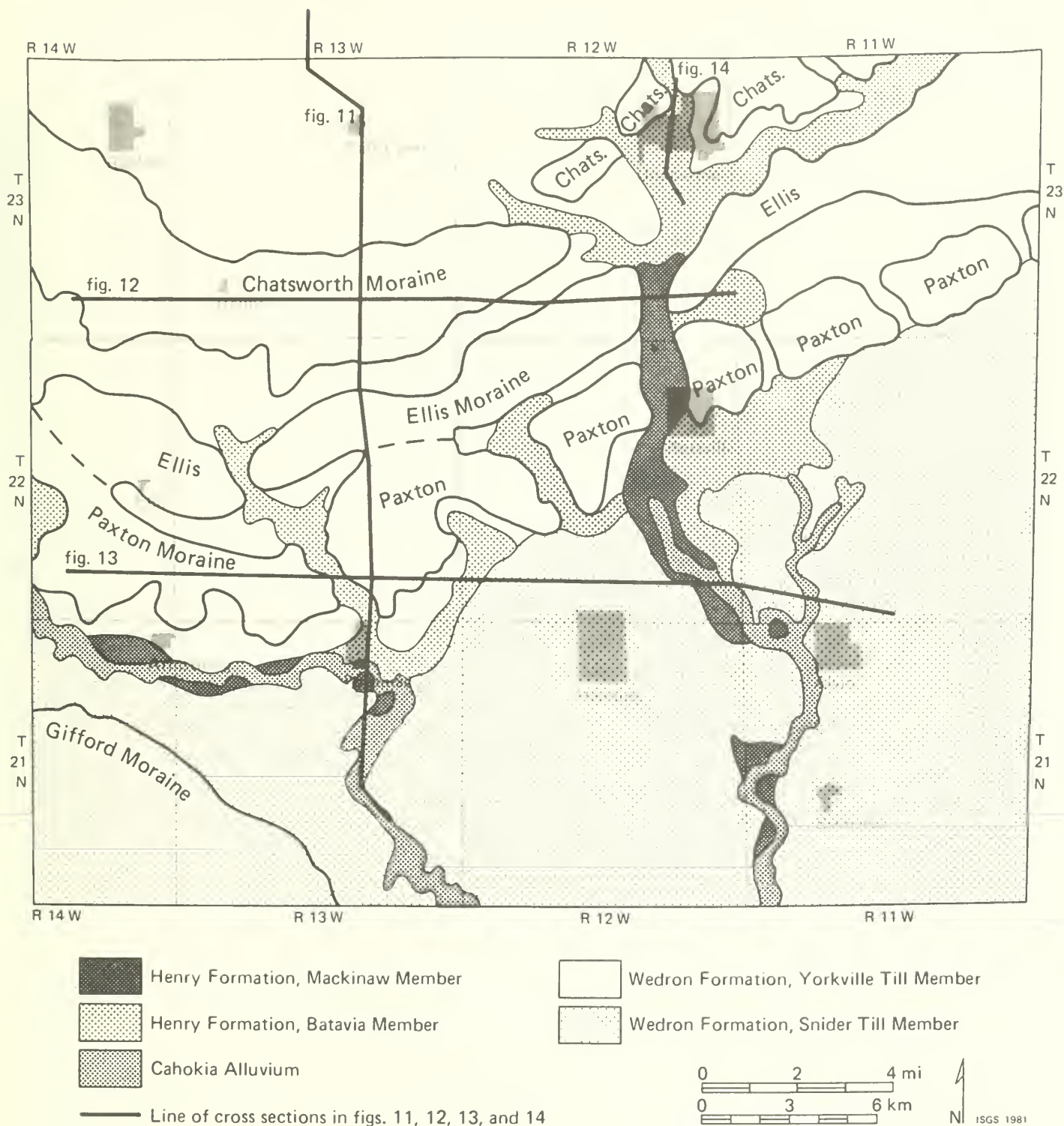
The bedrock surface directly below the glacial deposits ranges in age from Devonian to Pennsylvanian (fig. 3). It is composed principally of fine-textured siltstone and shale, although the Pennsylvanian rocks also contain thin beds of limestone, sandstone, and coal. Prior to continental glaciation during the Pleistocene, a complex drainage system of river valleys and tributaries was carved into the bedrock surface. A part of one of the major



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**Figure 1**

Map showing physiographic provinces and indicating study area (patterned area) in east-central Illinois (from Leighton, Ekblaw, and Horberg, 1948).



**Figure 2**  
Surficial geology of northern Vermilion County (from Lineback, 1979).

pre-glacial bedrock valley drainage systems, the Mahomet (Teays) Bedrock Valley System, is located in northern Vermilion County (Horberg, 1945, 1950). Horberg showed the deepest part of this valley at an elevation of just below 300 ft (91 m) above mean sea level along the northern county line, nearly 300 ft below the bedrock uplands of the central and southern part of the county. Results of the present study suggest that the deepest part of the valley is about 50 ft (15 m) higher than shown by Horberg.





limited supplies of potable ground water are available from the bedrock below these deposits because the fine-grained shallow bedrock is relatively impermeable and the water is highly mineralized within a few hundred feet of the bedrock surface. The ground-water potential of Vermilion County is therefore directly related to the occurrence of sand and gravel aquifers in the glacial deposits above the bedrock surface.

### **Bedrock geology**

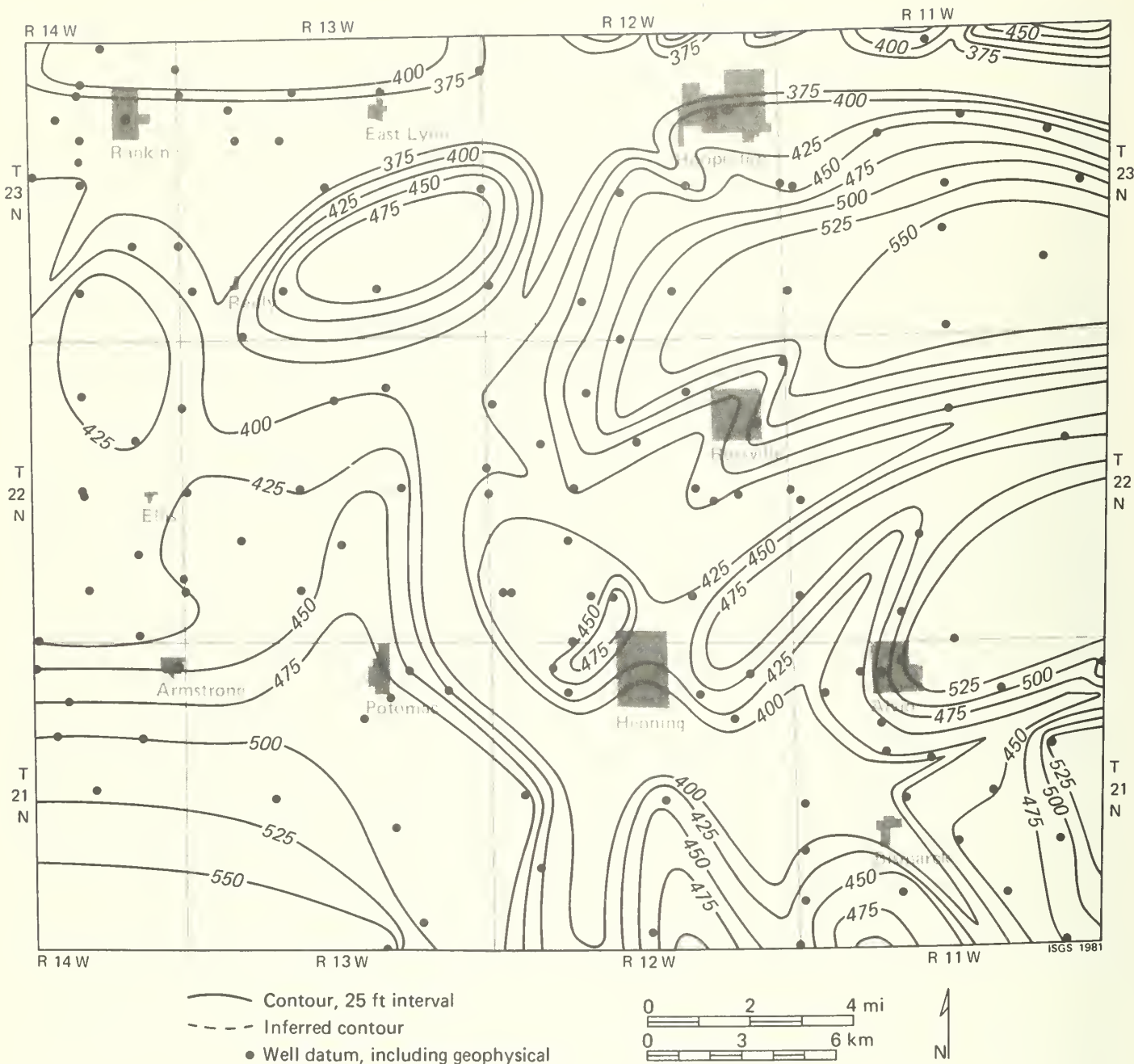
The bedrock surface below the glacial drift of northern Vermilion County is composed primarily of the Pennsylvanian Spoon, Carbondale, and Modesto Formations. The Pennsylvanian formations are mostly shale with thin beds of coal and some thin, discontinuous sandstone, siltstone, and limestone beds. In the northernmost tier of townships, erosional processes forming the Mahomet Bedrock Valley have exposed progressively older formations at the bedrock surface (fig. 3). The oldest is the Upper Devonian-Lower Mississippian New Albany Shale Group in the deepest part of the Mahomet Valley. Above the New Albany are the Burlington and Keokuk Limestones and the Warsaw Shale of the Valmeyeran Series (Middle Mississippian). All the rocks in the upper part of the bedrock of the study area are essentially non-water-yielding with the possible exception of the Burlington and Keokuk Limestones. Below a depth of about 300 to 350 ft (91 to 107 m), above the top of the Keokuk in this area, water is generally too highly mineralized for most uses.

### **Bedrock topography and drift thickness**

The principal features of the bedrock topography of northern Vermilion County (fig. 4) are the Mahomet Bedrock Valley and its northward-trending tributary, the Danville Bedrock Valley. The Mahomet Bedrock Valley has long been considered the principal control on the occurrence of the most significant sand and gravel aquifer within the glacial drift in east-central Illinois. Although the general location of the valley has been known since Horberg's work (Horberg, 1945, 1950), the actual location and configuration of the valley and its tributaries have been better defined as additional subsurface data have become available. The current map supports Cartwright's interpretation of the position of the valley (1972, unpublished) but follows Horberg in suggesting a more U-shaped valley. More significantly, the current map, following Cartwright, reduces the depth of the valley by at least 50 ft (15 m), eliminating the 300-ft contour previously shown by Horberg. There is evidence for elevations slightly below 350 ft (107 m) near Rankin; however, there are no firm data indicating elevations below 300 ft (91 m) "down valley" to the southwest for at least 30 miles (Stephenson, 1967). Current work by the Indiana Geological Survey supports this conclusion (Henry H. Gray, personal communication). While the geologic significance of this modification is yet to be fully developed, the practical implication is to reduce by at least 50 ft (15 m) the implied thickness of the Mahomet Sand which fills the valley.

The current bedrock topography map (fig. 4) also reveals the presence of a rather broad bench south of the deepest part of the valley in northwestern Vermilion County and probably extending westward into Champaign County. While the thalweg (deepest part of the valley) is mapped as slightly less than 350 ft (107 m) above mean sea level, the adjacent bench is about 425 ft above mean sea

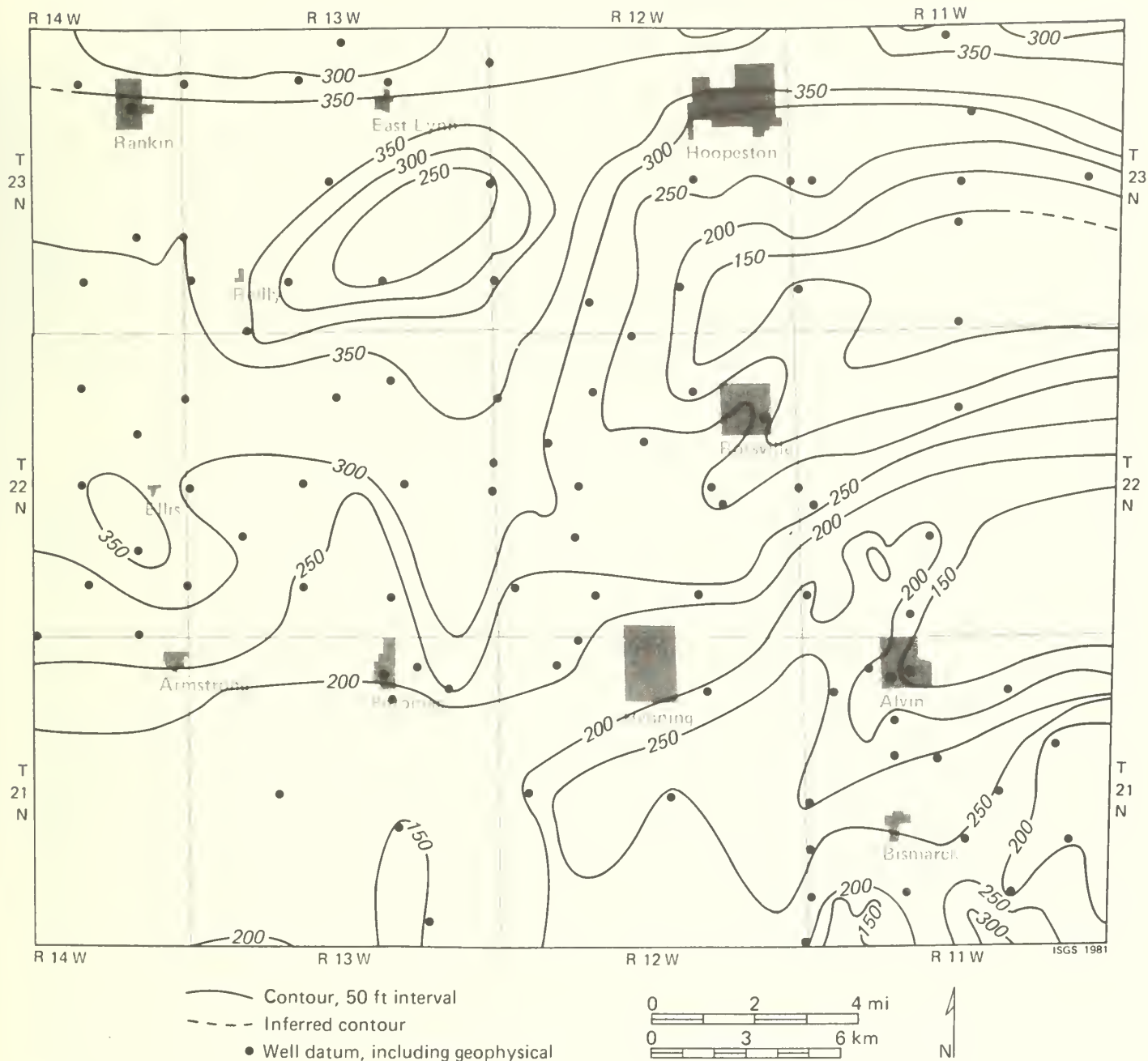




**Figure 4.**  
Bedrock topography of northern Vermilion County.

level and covers an area of about 140 square miles (360 km<sup>2</sup>). It is about 150 ft (46 m) below the general upland bedrock surface to the south and east.

Cutting through the eastern side of this bench is the Danville Bedrock Valley, shown by Cartwright as a rather narrow, fairly straight V-shaped valley trending north-northwestward from the city of Danville to its junction with the Mahomet Bedrock Valley two to three miles west of Hoopston. The current map suggests a somewhat more complicated system. The confluence of a number of tributaries just south of Henning is indicated; another tributary enters the system from the east about 5 miles (8 km) west of Rossville. Although this study does not suggest as significant a valley further south as shown



**Figure 5**  
Drift thickness of northern Vermilion County.

previously, a map of the entire county currently being prepared (W. H. Johnson, in preparation) may clarify the nature of the valley to the south.

As much as 370 ft (113 m) of glacial drift covers the bedrock surface in the northern part of the study area, thinning to less than 150 ft (46 m) in local areas of the southern part of the area (fig. 5). The drift thickness is controlled by the configuration of the bedrock topography and the present-day land surface, the latter the product of multiple glacial episodes during the Pleistocene. The areas of thick drift are most likely to contain significant sand and gravel aquifers, particularly where the thickest drift occurs over or adjacent to the buried bedrock valleys.

## Glacial drift units

Previous studies have provided the basic information on the stratigraphy, character, and distribution of the glacial deposits in Vermilion County and adjacent areas of east-central Illinois (Eveland, 1952; Johnson, 1971; Johnson, Gross, and Moran, 1972; Johnson, Follmer, Gross, and Jacobs, 1972). Much of this work has been based on exposures of the glacial deposits in natural and man-made cuts, particularly surface coal mines. The information required to adequately map and characterize the glacial deposits in the northern part of the county was generally not available, because relatively few water well logs and sample sets exist for that area. However, the rather extensive commercial test drilling over the past few years has provided a considerable number of downhole geophysical logs. These data sources and data from a regional aquifer study of east-central Illinois that included the southern half of Vermilion County have provided the basis for interpretation of the data currently available for northern Vermilion County.

Figure 6, a summary of the stratigraphic units present within the drift in northern Vermilion County, indicates the units considered potential aquifers. Much of this summary is based on an interpretation of the available geophysical logs correlated with data to the south, and is subject to verification or revision by future stratigraphic studies.

## DISTRIBUTION OF AQUIFERS

The principal aquifers of the area are contained in the Banner Formation (Mahomet Sand Member), the Glasford Formation (basal outwash), and the Henry Formation. This distribution, thickness, and depth to the Mahomet Sand and the Glasford outwash are shown in figures 7 through 10; cross sections of the entire drift sequence are shown in figures 11 through 13. Figure 10 also shows the distribution of the Henry Formation, a surficial sand and gravel unit that occurs in the valley of the North Fork, and, to a more limited extent, in the Middle Fork of the Vermilion River.

### Banner Formation, Mahomet Sand Member

The Banner Formation is locally the thickest of the drift formations present in northern Vermilion County, particularly over the bedrock valleys (figs. 6, 11-13). The formation may attain a maximum thickness of more than 250 ft (76 m); it includes as much as 150 ft (46 m) of till at the top and locally more than 125 ft (38 m) of sand and gravel (the Mahomet Sand Member) at the base. There is some suggestion, primarily on the basis of downhole geophysical data, that the Mahomet Sand may locally contain, and/or overlie, beds of till or other fine-textured sediments.

Figure 7 shows the elevation of the top and thickness of the Mahomet Sand while Figure 8 shows the depth to the top of the sand from land surface.

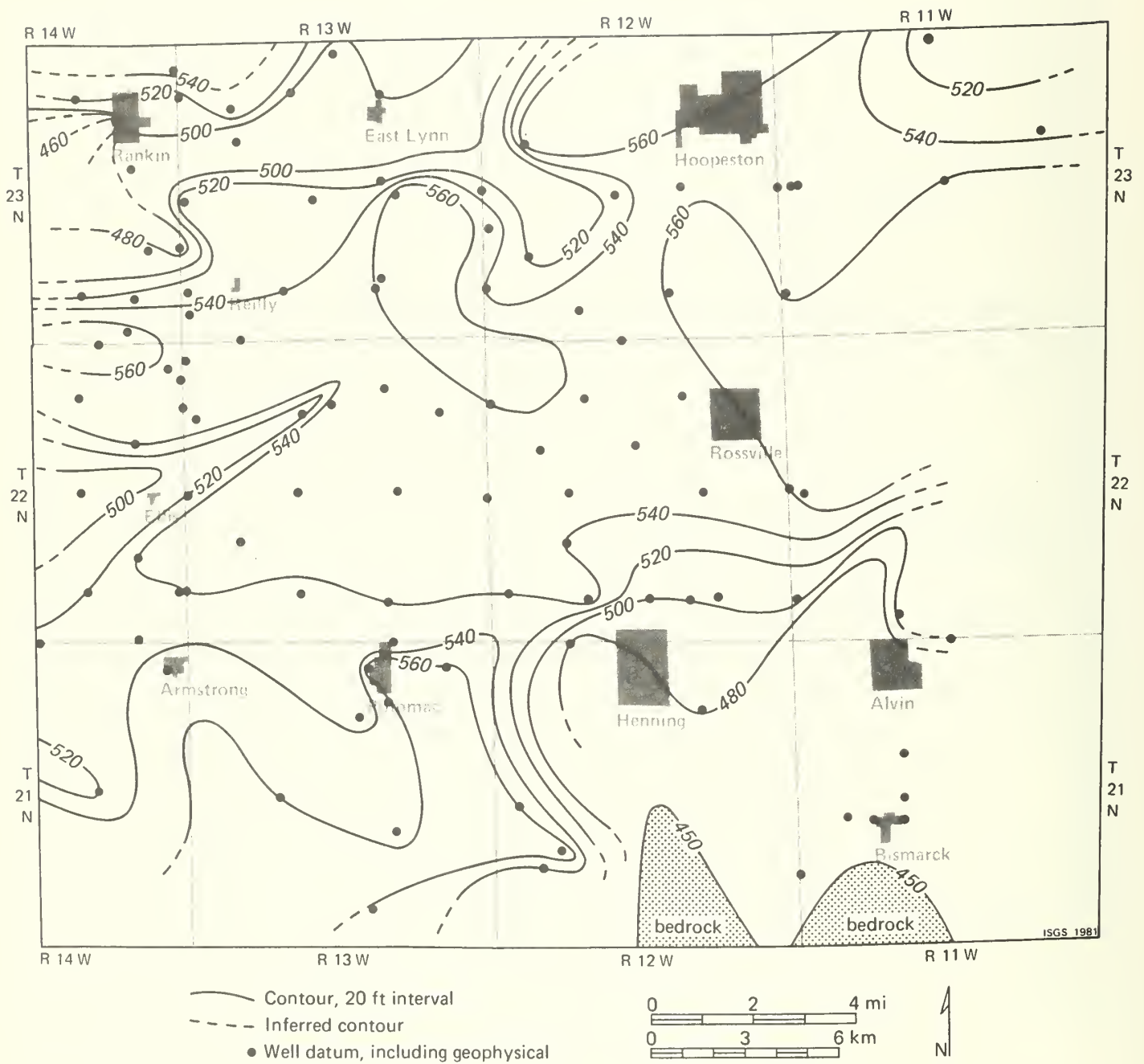
Two significant features are shown in Figure 7. The greatest thickness of sand and gravel appears to be only partly controlled by the position of the buried valleys, and the surface of the Mahomet Sand locally has significant relief in some areas, possibly due to post-depositional erosion. The highest elevation of the top of the sand is slightly more than 560 ft (171 m),



STAGE SUBSTAGE		FORMATION, MEMBER, UNIT	MATERIAL POTENTIAL AS AQUIFER
QUATERNARY SYSTEM, PLEISTOCENE SERIES	HOLOCENE	Cahokia Alluvium	Mostly fine-textured, some sand and gravel locally. Not a source of large ground-water supplies.
	WISCONSINAN	Valderan	Clayey silt, non-aquifer
		Twocreekan	
		Woodfordian	Henry Formation Locally small municipal supplies Wedron Formation Some thin, discontinuous interbedded and basal sand and gravel. Small supplies locally.
		Farmdalian	Silt, organic silt; non-aquifer material
		Altonian	
	SANGAMONIAN		
	ILLINOIAN	Glasford Formation (undifferentiated)	Mainly till with thin, discontinuous sand and gravel. Small supplies locally.
		Glasford outwash	Rather extensive sand and gravel at base. Local source of municipal supplies.
	PRE-ILLINOIAN	Banner Formation (undifferentiated) mainly till	Thin, discontinuous sand and gravel interbedded in massive till. Not considered an aquifer in this area.
		Mahomet Sand Member	Mainly sand and gravel, locally interbedded till or silt. Principal aquifer throughout much of northern Vermilion County.
	Bedrock, Pennsylvanian and older		Generally not considered a source of ground water in this area.

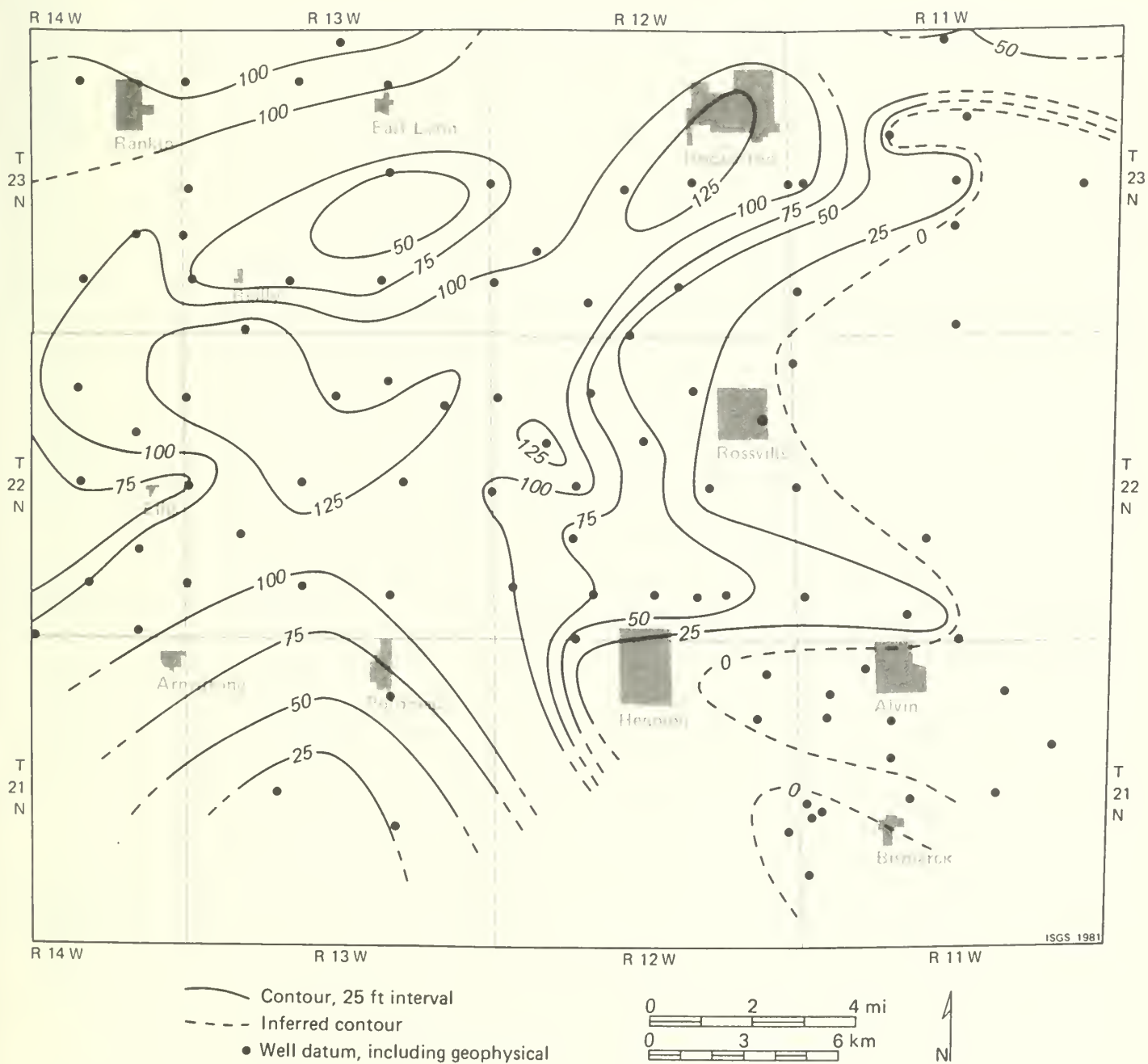
Figure 6.  
Generalized stratigraphic column of glacial drift in northern Vermilion County.

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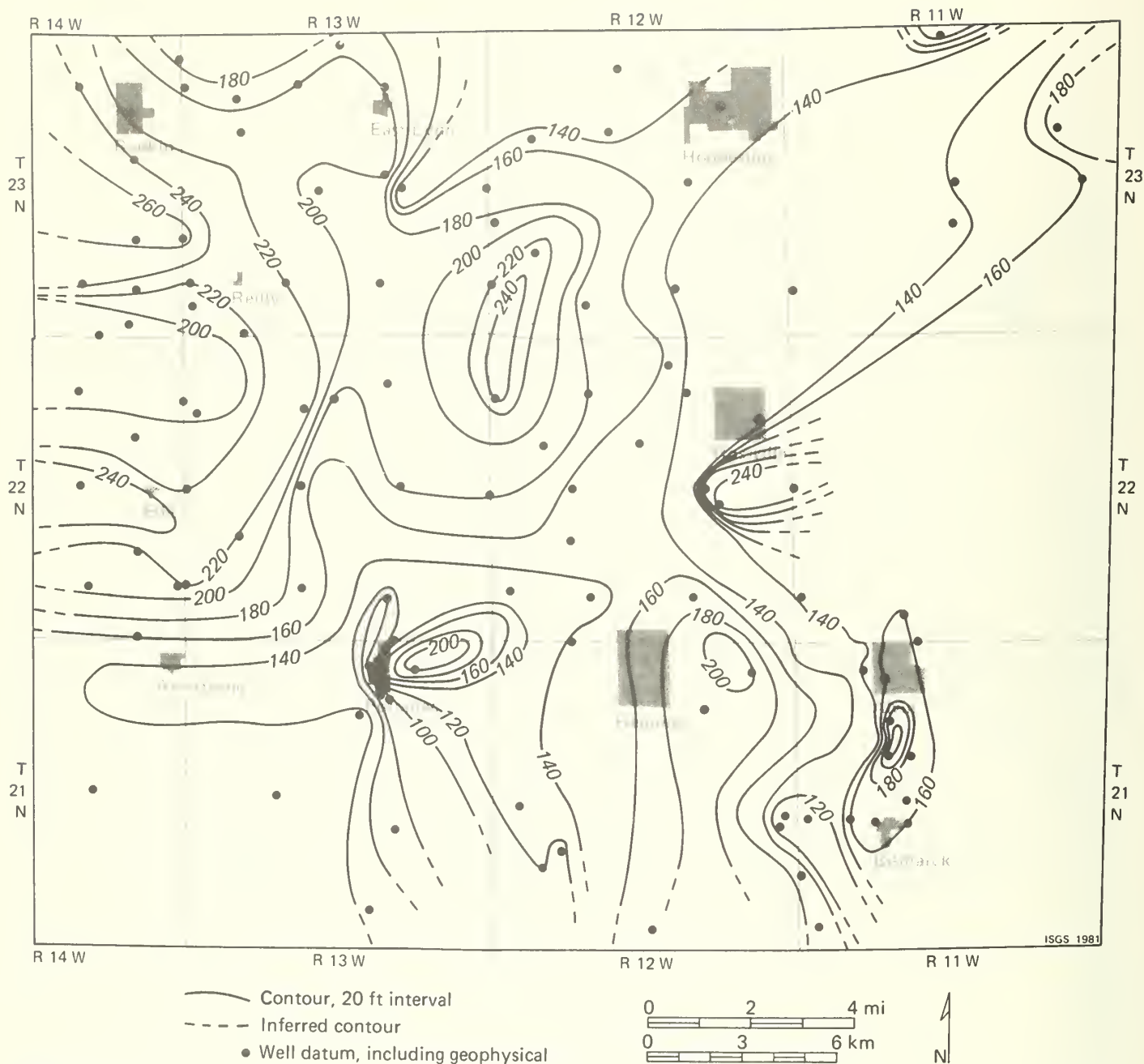


**Figure 7a**  
 Elevation of the top of the Mahomet Sand in northern Vermilion County.





**Figure 7b.** Thickness of the Mahomet Sand in northern Vermilion County.



**Figure 8**

Depth to the top of the Mahomet Sand in northern Vermilion County. Presence of depth contours in the southeastern part of the area does not necessarily imply the presence of significant water-yielding materials in the Mahomet Sand.

primarily in the central part. However, for more than half the area, the elevation of the surface of the underlying Mahomet Sand is about 540 ft (165 m), covering the central part from Hoopeston southwest to a point north of Armstrong. The thickest sand and gravel is in this area. What appear to be valleys cut into the surface of the Mahomet Sand are usually oriented east to west along the northern and southwestern part of the area. The lowest elevation mapped on the surface of the sand, less than 480 ft (146 m), is just west and south of Rankin. This apparent erosional feature in the northwestern corner of the county directly overlies the thalweg of the Mahomet Valley. Therefore, the thickest sand and gravel forms a northeast-to-southwest band from Hoopeston to just north of Armstrong.

Since the depth to the top of the Mahomet Sand (fig. 8) is controlled by the elevation of the top of the unit as well as by the land surface configuration, the greatest depth to the top of the sand is in the northwestern part of the area where the crest of the Chatsworth Moraine coincides with the Mahomet Bedrock Valley.

The Mahomet Sand does not appear to be present in the Danville Valley or its tributaries east of Rossville and southeast of Henning. Although little data are available, it is likely that these areas were ponded during the deposition of the sand and gravel to the north and west; and as a result, they contain only fine-textured materials with limited water-yielding properties. Similar conditions exist in similar areas along the Mahomet Valley System.

### **Glasford Formation outwash**

The Glasford outwash, sand and gravel at the base of the Glasford Formation (figs. 6 and 9), is the second most significant aquifer in northern Vermilion County. This unit, although not as thick or extensive as the Mahomet Sand, occurs at a shallower depth (figs. 9-13) and is locally more than 60 ft (18 m) thick. The top of the outwash is generally found in the elevation range of 600 to 660 ft (183 to 201 m) from northeast of Hoopeston to just northwest of Rossville (fig. 9). The top of the outwash reaches an elevation of 640 ft (195 m) generally in a band from the vicinity of Rossville westward to an area about 6 miles (9.6 km) south of Rankin. The lowest elevations are found southeast of Bismarck and Henning.

The most extensive area of outwash more than 40 ft (12 m) thick occurs in a band 2 to 4 miles (1.2 to 2.4 km) wide extending from northeast of Hoopeston southwestward to just west of Potomac. Thinner deposits extend to the vicinity of East Lynn, to the northeast of Henning, and to the north of Armstrong. Sand and gravel less than 40 ft (12 m) thick (probably averaging slightly less than 20 ft [6.1 m]) underlies most of the rest of this region and is often locally absent.

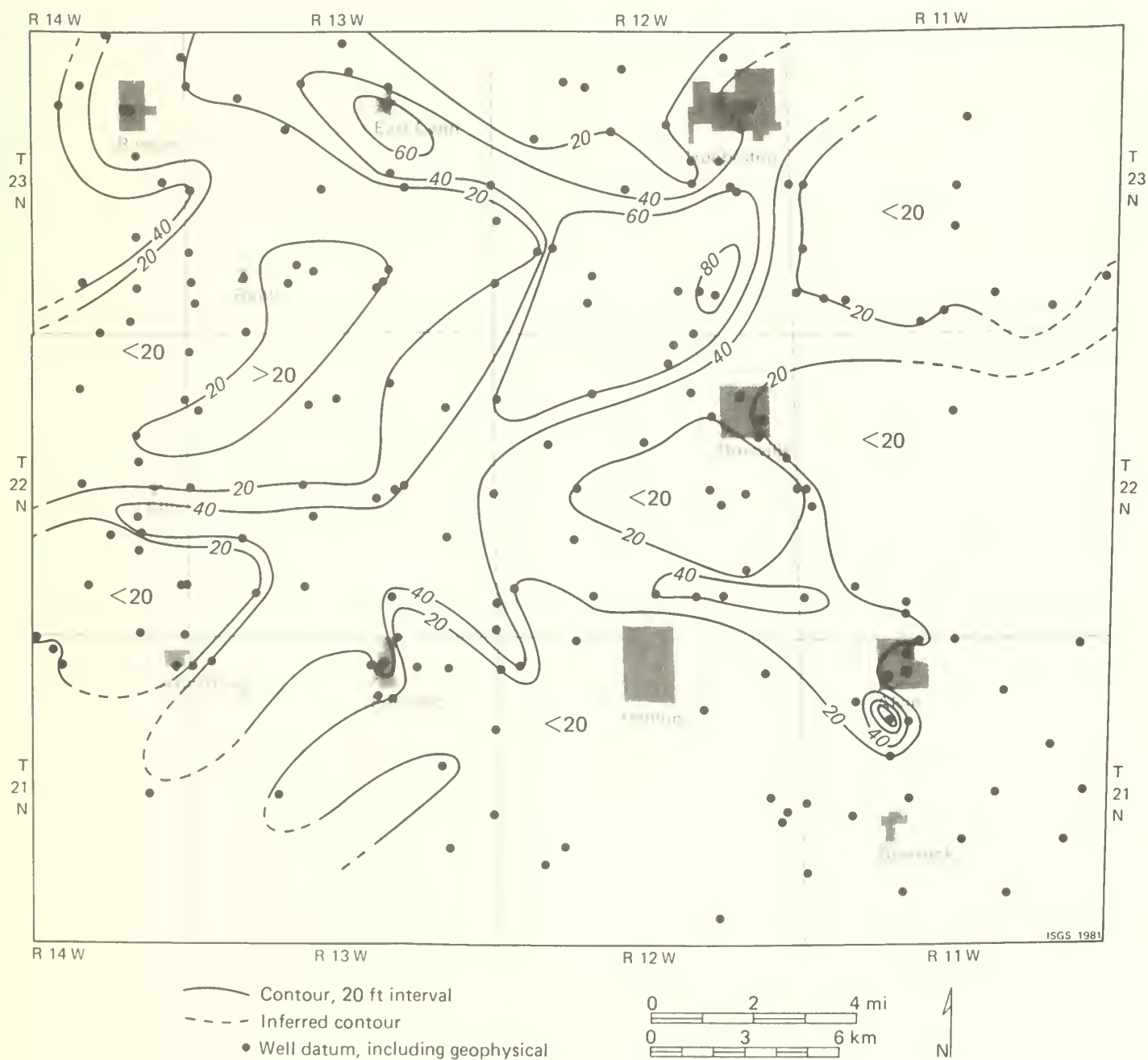
The Glasford outwash is generally less than 125 ft (38 m) below land surface, although in a few areas between Rankin and Potomac-Armstrong the land surface is nearly 150 ft (46 m) above the sand and gravel (fig. 10). There are also areas where it lies within 50 ft (15 m) of the surface, including an extensive area along the North Fork of the Vermilion River. Sand and gravel outwash deposited in the North Fork Valley locally appears to intersect the Glasford Formation sand and gravel, forming a continuous deposit from the land surface to the base of the Glasford Formation sand and gravel. Specific areas where this appears to occur are just south of Hoopeston and southeast of Bismarck.

### **Surficial sand and gravel aquifers**

Although no significant sand and gravel aquifers appear to be present within the Wedron Formation in northern Vermilion County, significant surficial sand and gravel deposits occur within the valley of the North Fork, and to a lesser extent, in the Middle Fork Valley of the Vermilion River. These deposits, assigned to the Henry Formation (figs. 6, 10-13) were deposited in an erosional trench cut into or through the Wedron Formation and locally into the Glasford Formation.

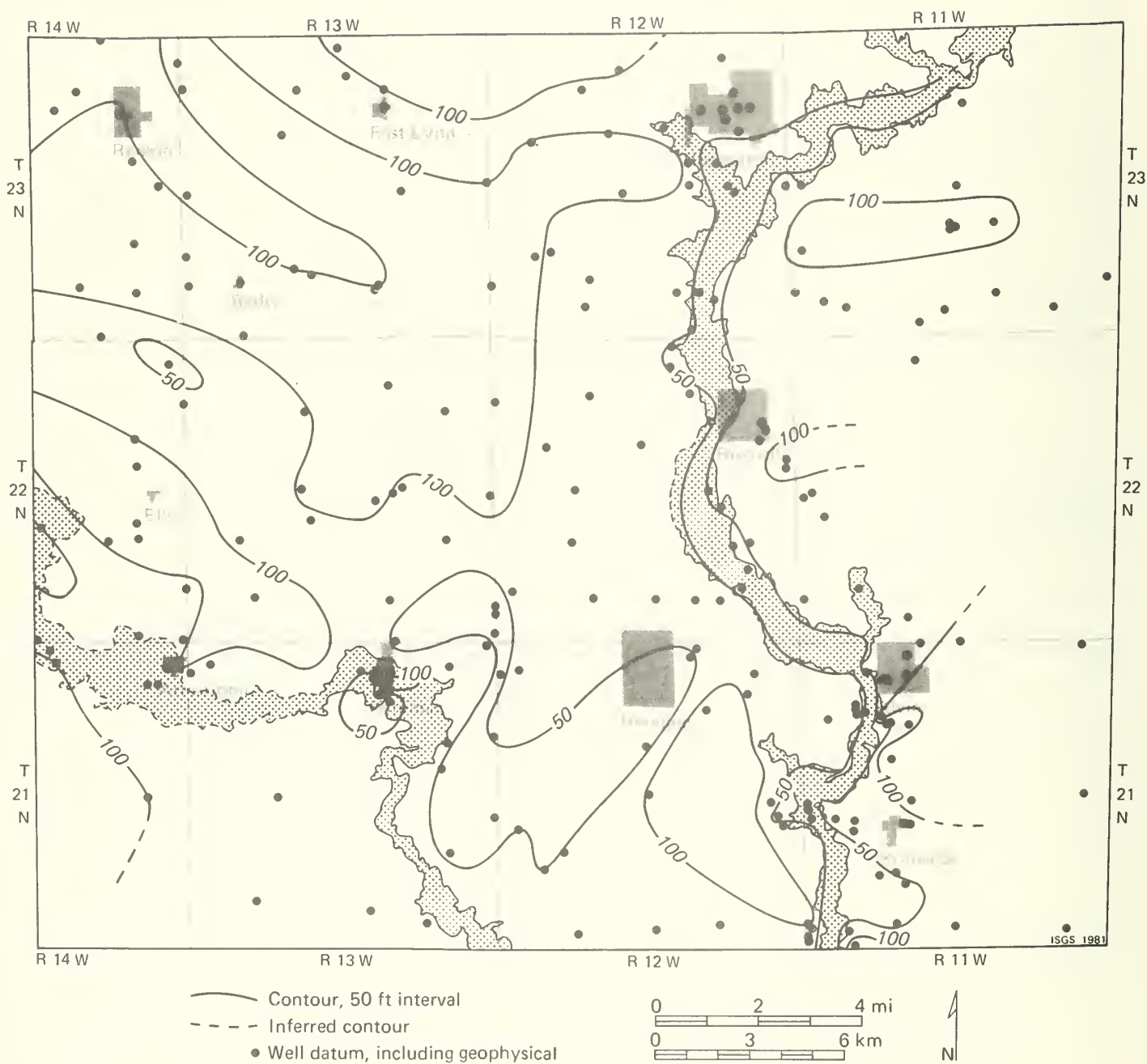






**Figure 9b** \_\_\_\_\_  
 Thickness of the Glasford outwash in northern Vermilion County.





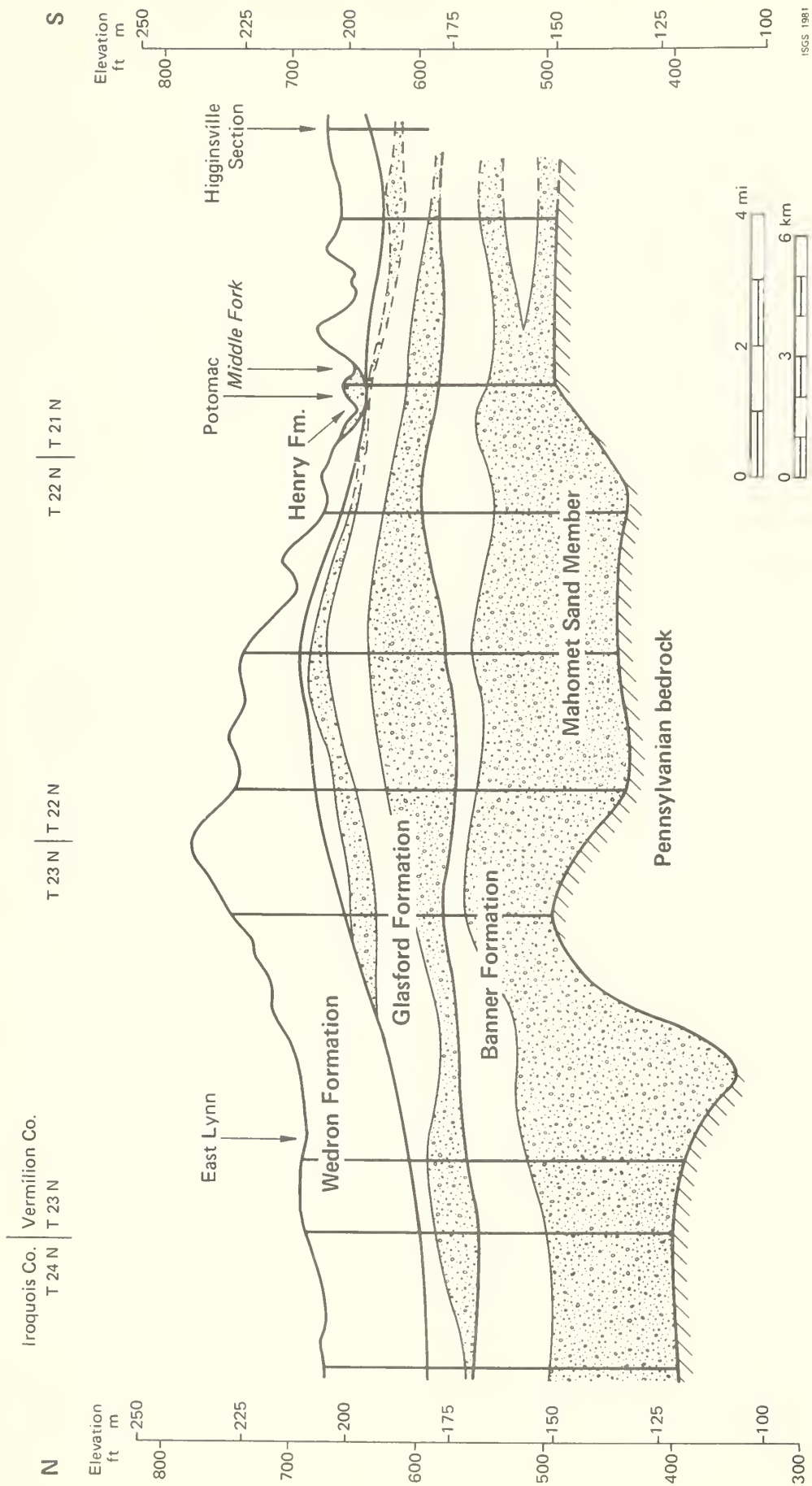
**Figure 10** Depth to the top of the Glasford outwash and occurrence of the Henry Formation (patterned area) in northern Vermilion County.

The Henry Formation attains its greatest thickness along the North Fork, where at least 50 ft of sand and gravel is reported in some well records. Some reworked sand and gravel may also be included in the modern stream alluvium (Cahokia Alluvium), although these deposits are probably insignificant as aquifer material. Mapping by Johnson (in preparation) suggests that at least 20 ft (6 m) of sand and gravel occurs along most of the North Fork. The Henry Formation within the North Fork Valley would appear to be a significant aquifer for local residents and for small communities in or near the valley. Wells developed in the Henry Formation would be relatively shallow, and exploration for the best well sites would be comparatively easy and economical.

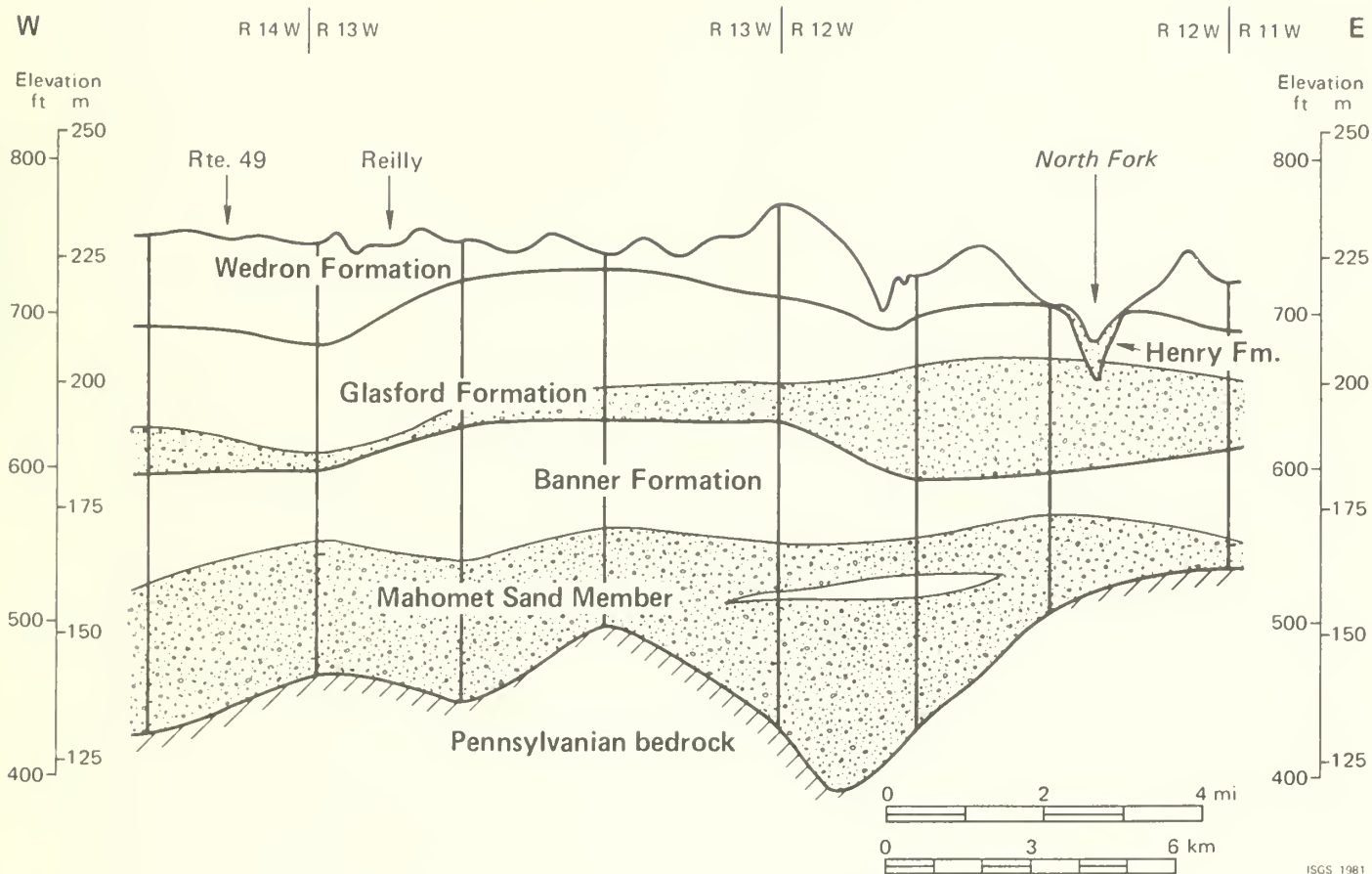
Some sand and gravel occurs in the Henry Formation all along the Middle Fork, but it is seldom more than 20 ft thick. Since the top of the Glasford Formation outwash generally appears to be below an elevation of 620 ft (190 m) between Potomac and Armstrong, and the top of the Henry Formation is between 670 and 700 ft (204 and 213 m) elevation, the Henry Formation apparently does not intersect the Glasford outwash along the Middle Fork in this area and consequently appears to be of limited importance as an aquifer there. As a separate aquifer, the Henry Formation is therefore of limited importance along the North and Middle Fork Valleys. Its presence becomes more significant in areas where it is superposed over other aquifers in the area. As noted above, the Henry Formation locally intersects the Glasford Formation outwash. One example of this intersection occurs in a small area south of Alvin in the North Fork Valley where the combined thickness of sand and gravel is greater than 80 ft (24 m). A significant part of the Henry Formation in the North Fork Valley may intersect the Glasford outwash or be separated by only a thin layer of finer-grained sediments (figs. 2, 10). Because sand and gravel possesses greater permeability than the surrounding glacial till, movement of ground water between the Glasford aquifer and the Henry Formation is much more rapid where they are in contact with sand and gravel than where they are separated by till.

The rate of movement of water between the various aquifers and surface sources becomes important since the North Fork has been considered for use as an open channel to transport water from pump sites to the reservoir in Danville. A brief study of the static water levels in wells located along the North Fork drainageway reveals that much of the North Fork Valley is a potential discharge area for both the Glasford outwash and the Henry Formation aquifers. Along about two-thirds of the valley, static water levels in wells equal or exceed the water level in the North Fork River. Flowing wells occur along much of the valley.

The role of the Henry Formation in bank storage must also be considered in calculations involving water loss or gain when the river is acting as an aqueduct. During flood stage, water is rapidly absorbed and retained in the permeable Henry Formation adjacent to the river; then as the water level in the river recedes, this water seeps or flows back into the river valley. Pumping into the river should begin as soon as normal base flow or a predetermined, artificially maintained base flow is approached. If the river level were allowed to recede too far before pumping began, a significant



**Figure 11** North-south cross section from north of East Lynn to south of Potomac (see fig. 2 for lines of cross section). Pattern indicates sand and gravel.



**Figure 12**  
East-west cross section three miles south of Route 9 (see fig. 2). Pattern indicates sand and gravel.

quantity of water would initially be lost to bank storage, as the bank storage capacity requirements must be met before equilibrium conditions are reached and water loss minimized.

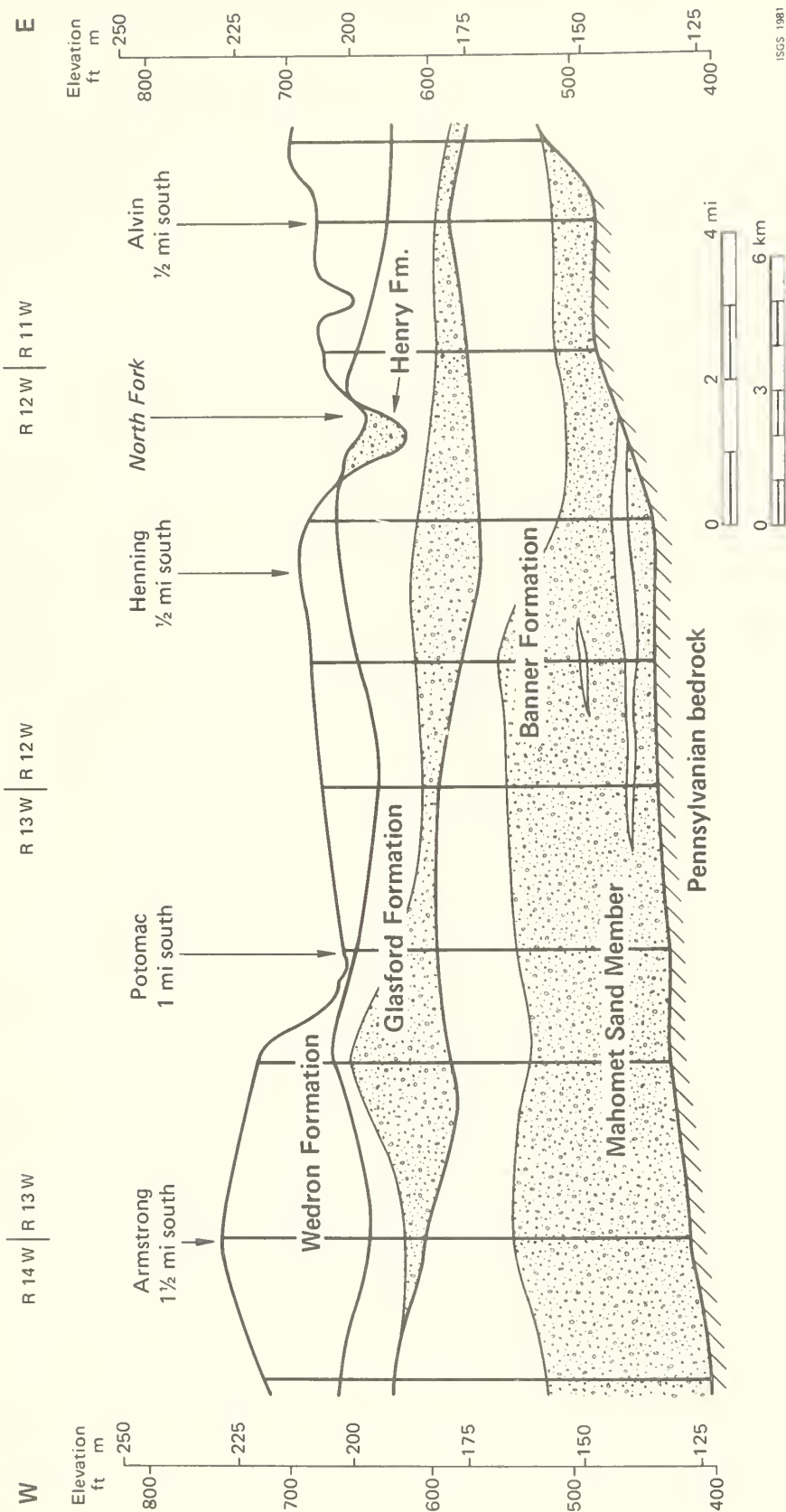
Water loss due to aquifer recharge would probably be relatively minor along most of the North Fork Valley in the study area; however, water loss through bank storage could be significant if river levels were allowed to drop too far before pumping began.

## PUBLIC WATER SUPPLIES

### Hoopeston

Hoopeston, in northeastern Vermilion County (fig. 2), is the largest city in the region to use ground water for its public water supply. It currently obtains water from four wells 98 to 110 ft (30 to 34 m) deep in the west-central part of town. In addition, industrial wells drilled by the several canning companies in town also produce large amounts of water from this aquifer. All the wells are completed in the Glasford outwash aquifer.





**Figure 13** East-west cross section about two miles north of Route 136 (see fig. 2 for lines of cross section). Pattern indicates sand and gravel.



The pre-Wisconsinan drift consists of coarser materials ranging in texture from fine sand to gravel. The coarser materials occur in two horizons. In the vicinity of Hoopeston, the Glasford outwash lies at a depth of 60 to 120 ft (18 to 36 m).

The Glasford outwash, at a depth of 60 to 120 ft (18 to 36 m) in the vicinity of Hoopeston, lies at an elevation of from 580 to 650 ft above sea level and has a maximum thickness of more than 60 ft (18 m) beneath Hoopeston. South of Hoopeston its surface rises and the deposit is directly overlain by sands and gravels of the Wisconsinan Henry Formation (fig. 14).

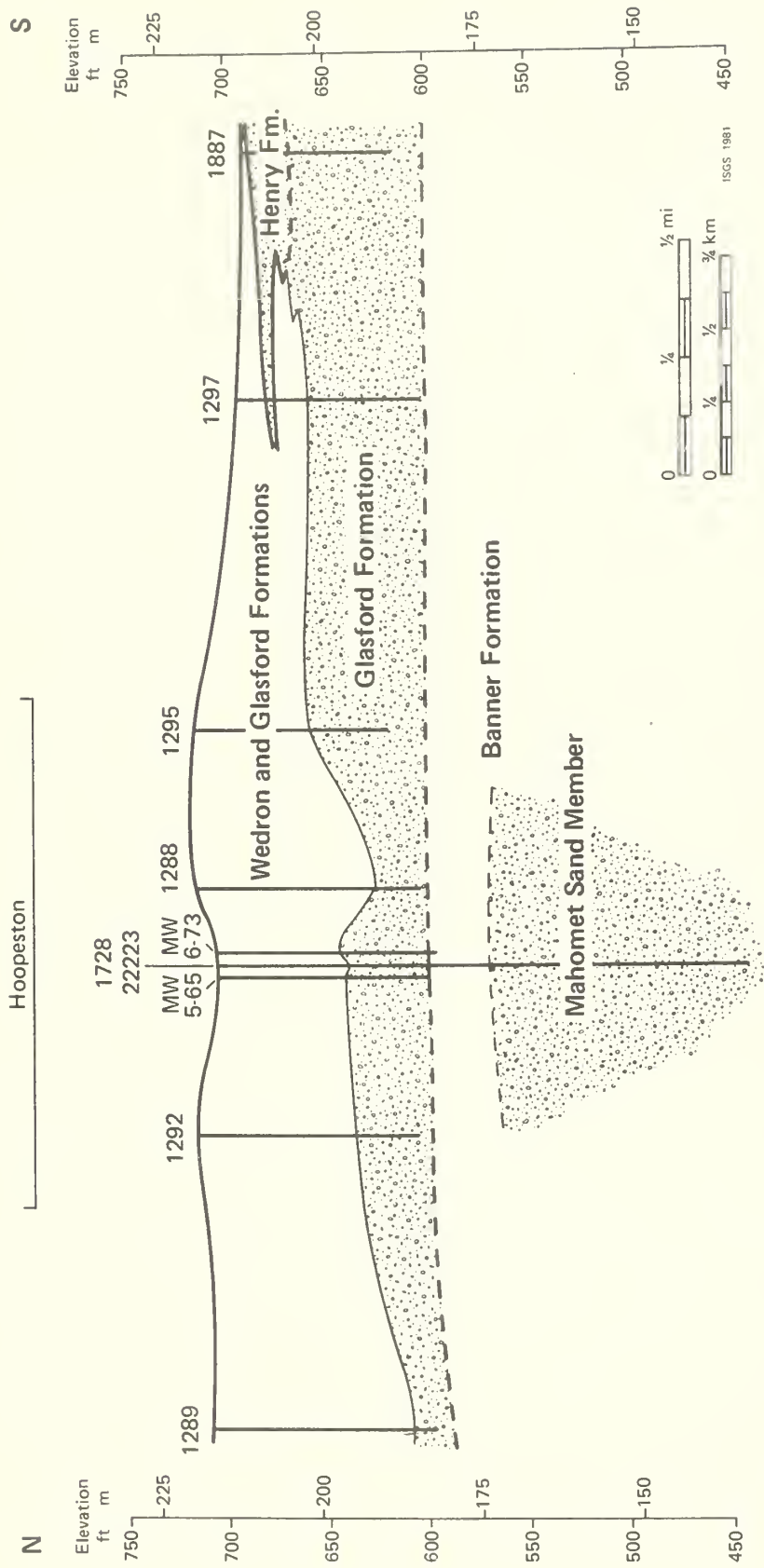
Although data on the lower sand and gravel unit (the Mahomet Sand) are sparse, figure 14 indicates that the Mahomet Sand is present between elevations of 433 to 570 ft (132 to 124 m) above mean sea level, corresponding to depths of 135 ft (41 m) to more than 270 ft (82 m) at Hoopeston. There is also some indication of secondary carbonate cementation which, if present, may restrict the water-yielding capacity of the formation. The extent and degree of cementation in the Mahomet Sand is impossible to ascertain because of inadequate data. Regional trends show that the deposit is part of a larger unit associated with the buried Mahomet Valley.

Table 1 lists the numbered municipal wells in Hoopeston, their current status, and their aquifer characteristics. A typical log for these wells shows about 46 to 65 ft (14 to 20 m) of glacial till over 40 to 71 ft of sand and gravel of varying textures.

Because the sand and gravel aquifers beneath Hoopeston are thick and extensive, there should be little problem in satisfying increased demand for ground water. Any new wells drilled should be located far enough apart to prevent interference from adjacent wells.

Table 1. Hoopeston wells and aquifer characteristics (data from State Water Survey files).

Well no.	Year drilled	Depth (ft)	Status	Location	Hydraulic conductivity (gpd/ft <sup>2</sup> )	Pumping rate (gpm)	Aquifer thickness (ft)
1	—	117	ab'd	11-23N-12W	2370	1000	40
2	—	123	ab'd	11-23N-12W	3450	100	—
3	1914	110	in use?	11-23N-12W	2070	145	70
4	1927	110	in use?	11-23N-12W	2300	760	63
5	1965	104	in use	11-23N-12W	2100	1543	71
6	1973	98	in use	11-23N-12W	—	—	—



**Figure 14** North-south cross section through Hoopeston showing location of sand and gravel as well as county and municipal well identification numbers.

Table 2. Rossville wells and aquifer characteristics (data from State Water Survey files).

Well no.	Year drilled	Depth (ft)	Status	Location	Hydraulic conductivity (gpd/ft <sup>2</sup> )	Pumping rate (gpm)	Aquifer thickness (ft)
1	1918	132	ab'd	12-22N-12W	670	235	27
2	1910	131	ab'd	12-22N-12W	—	—	—
3	1928	133	ab'd	12-22N-12W	370	150	65
4	1973	127	in use	12-22N-12W	—	—	—
5	1973	135	in use	12-22N-12W	—	—	—

### Rossville

The village of Rossville is in northwestern Vermilion County, about 5 miles south of Hoopeston. The glacial drift is somewhat thinner than at Hoopeston (200 to 250 ft [61 to 76 m]) and the bedrock surface occurs in the range of 425 to 500 ft (130 to 152 m) above mean sea level. The glacial drift at Rossville is similar in character to that at Hoopeston, with the Yorkville Till Member of the Wedron Formation forming the Paxton Moraine that passes through Rossville. Surficial outwash deposits of the Henry Formation are present west of town. The contact between younger Wisconsinan and older Illinoian drift occurs at a depth of less than 140 ft (43 m). All Rossville wells have obtained water from the Glasford outwash aquifer. Table 2 lists the numbered municipal wells, their current status, and aquifer characteristics.

The Rossville Packing Company has three wells in Section 12 finished at depths ranging from 107 to 137 ft (33 to 42 m). Available data indicate that the drift aquifers at Rossville probably will be able to provide a sufficient supply of ground water for the foreseeable future. The most promising area for exploration seems to be the northwest: The Mahomet Sand thickens to more than 100 ft (30 m) within 3 miles (5 km) west and northwest of Rossville; the Glasford outwash thickens to more than 40 ft (12 m) to the northwest of Rossville; and the surficial Henry Formation is well developed at the northwest edge of town.

### Potomac

Potomac is located in the southwestern part of the study area in Section 3, T. 21 N., R. 13 W. The glacial drift is similar to that at Rossville and Hoopeston. At Potomac the glacial drift is 170 to 200 ft (52 to 61 m) thick and the bedrock surface occurs at an elevation of 450 to 490 ft (137 to 149 m) above mean sea level.

Table 3. Potomac wells and aquifer characteristics (data from State Water Survey files).

Well no.	Year drilled	Depth (ft)	Status	Location	Hydraulic conductivity (gpd/ft <sup>2</sup> )	Pumping rate (gpm)	Aquifer thickness (ft)
M.W. 1	1950	110	ab'd	3-21N-13W	—	—	—
M.W. 2	1950	115	ab'd	3-21N-13W	—	—	—
M.W. 3	1950	120	ab'd	3-21N-13W	94	14	31
M.W. 4	1964	188	in use	3-21N-13W	1460	76	89
M.W. 5	1973	178	in use	3-21N-13W	—	—	—
C.P. 1 (west)	1973	110	in use	3-21N-13W	—	—	—
C.P. 2 (east)	1973	110	in use	3-21N-13W	—	—	—

M.W. = municipal well

C.P. = city park well

Unique features of the Potomac area are the flowing wells developed in the Glasford outwash and the Mahomet Sand aquifers. For a number of years, they have supplied all the town's ground-water needs. In addition to the village wells, two additional wells were drilled in the city park west of town, and a Memorial Artesian Well was constructed in front of the Middle Fork Township Hall. Table 3 summarizes the Potomac well locations, their current status, and aquifer characteristics.

## Rankin

The village of Rankin, in the northwest corner of Vermilion County (Sections 11 and 12, T. 23 N., R. 14 W.), is about 13 miles west of Hoopeston. The village is situated over the northern flank of the buried Mahomet Bedrock Valley, and the bedrock surface rises from an elevation of 350 (107 m) to about 400 ft (122 m) at the north edge of town. Drift thickness reflects the bedrock surface topography, thickening from 325 ft (99 m) on the north edge of town to about 375 ft (114 m) on the south edge where the valley is deeper.

The pre-Wisconsinan sediments at Rankin are composed mostly of till and outwash. The upper portion of the sequence is predominantly till with a few thin interbedded layers of sand interspersed. The lower part of the Glasford-Banner drift succession is primarily sand and gravel (the Mahomet Sand), with minor beds of till and other finer-grained sediments. Data from a structure test near the village wells indicate that the sand and gravel may be as much as 150 ft (46 m) thick, although the two village wells penetrate only 14 ft (4 m) and 20 ft (6 m) of it, respectively.

Two wells located near the center of Rankin draw water from the Mahomet Sand. The wells were constructed in 1915 and 1926 and their locations are as follows:



Well No. 1, 2400 ft N., 450 ft W., SE/c 11-23N-14W T.D. 270 ft

Well No. 2, 2400 ft N., 432 ft W., SE/c 11-23N-14W T.D. 282 ft

Although both the Mahomet Sand and the Glasford outwash aquifers are somewhat less well developed within Rankin, ground-water availability should pose no major problem. The Mahomet Sand appears to be thicker and potentially more productive within a mile (1.6 km) to the north and northeast, and the Glasford outwash thickens to over 40 ft (12 m) within two miles (3 km) of Rankin.

### **Bismarck**

The Bismarck Community Water District, the only other municipality in northern Vermilion County with a public water supply, is in the southeastern part of the study area about 8 miles south-southeast of Rossville in Section 20, T. 21 N., R. 11 W. The glacial drift is 250 to 375 ft (76 to 114 m) thick and the bedrock surface occurs at an elevation of 400 to 425 ft (122 to 130 m) above mean sea level.

The drift is composed mainly of till to a depth of 160 to 175 ft (49 to 53 m) below which occurs a silty sand and gravel unit overlying a cleaner sand and gravel to a depth of at least 211 ft (64 m). The true thickness of the unit is not known; the bedrock surface is believed to be 40 to 70 ft (12 to 21 m) deeper than the deepest well around Bismarck, and logs of wells in the area do not indicate if bedrock or an impermeable drift stratum were reached.

A well drilled in August 1969 to a depth of 201 ft (61 m) located 630 ft (192 m) west and 2930 (893 m) north of the SE/c Section 20, T. 21 N., R. 11 W., is the source of supply for the village water distribution system. It is finished in the Mahomet Sand Member contained within the Danville Bedrock Valley.

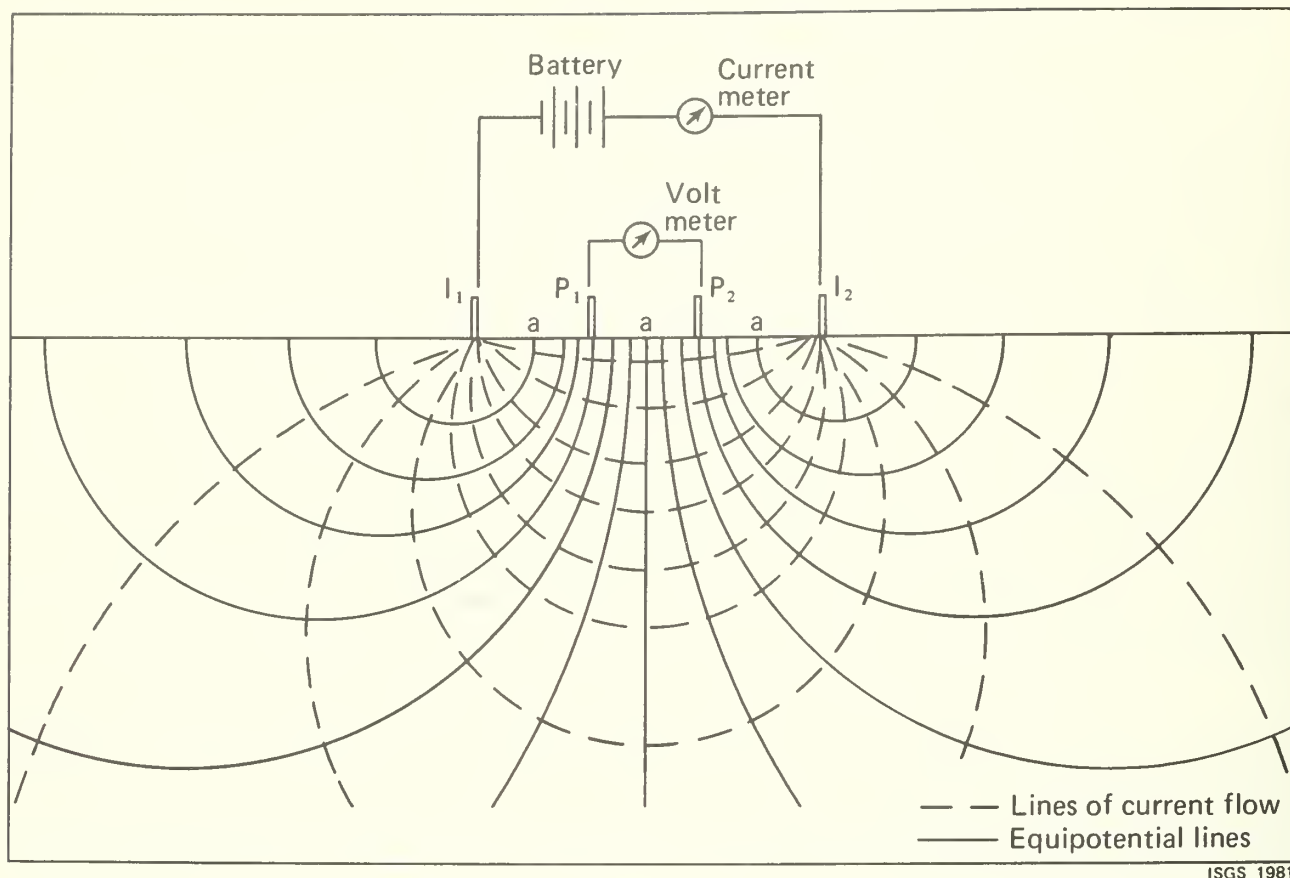
### **Armstrong and Henning**

The villages of Armstrong and Henning do not have public ground-water supplies according to files at the Illinois State Water Survey.

## **GEOPHYSICAL STUDY**

To supplement the existing geologic information on the aquifer systems of northern Vermilion County an electrical earth resistivity survey was conducted in the area.

In addition to the basic electrical properties of the materials two principles govern the resistivity of earth materials: (1) resistivity tends to decrease with an increasing amount of water in the pore spaces; and (2) resistivity tends to decrease with increasing salinity, or free-ion content, of the water in the pore spaces. Massive rocks with only a small amount of pore space generally fall into the category of high-resistivity earth materials; sand and gravel saturated with fresh water is also in this category. If the sand and



**Figure 15**

Basic elements of an earth resistivity meter and the Wenner electrode configuration.

gravel contains clay or soil particles, then the resistivity will be reduced. Most soils, unless they are exceedingly dry, fall into the category of medium- to low-resistivity materials; also in this category are badly weathered or highly fractured rocks.

The above discussion is somewhat over-simplified, since many other factors also influence the resistivity values of earth materials. In sand and gravel deposits, for example, energy levels of deposition (packing), sorting, grain shape, and surface conductance of the rocks all influence resistivity values.

The Wenner electrode configuration was used in this survey. With this configuration, four electrodes are equally spaced at intervals 'a' along a straight line. The two outside electrodes,  $I_1$  and  $I_2$ , are the current electrodes and the two inner electrodes,  $P_1$  and  $P_2$ , are the potential electrodes (fig. 15).

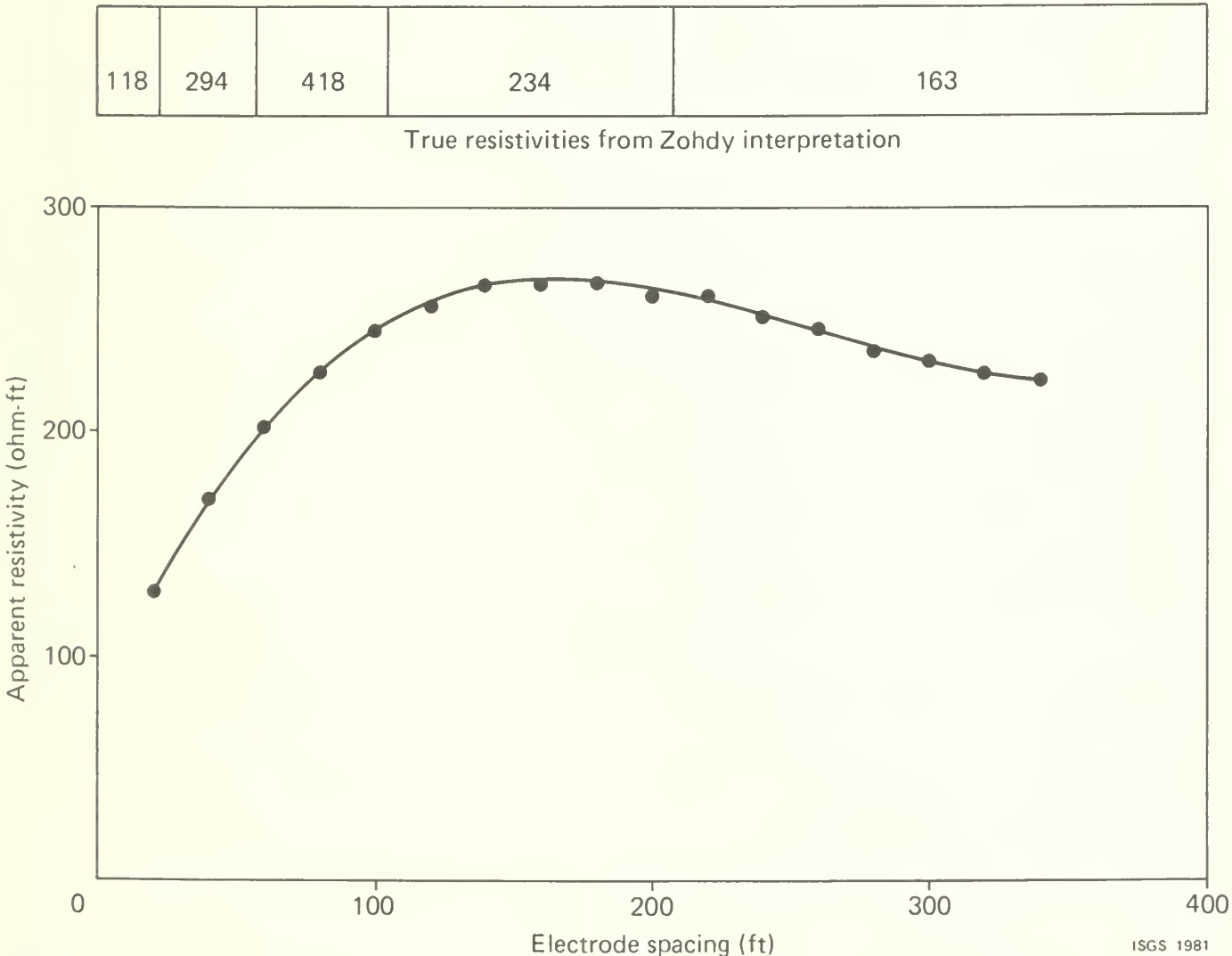
For the Wenner electrode configuration, the resistivity of a homogeneous medium is given by

$$\rho = 2\pi a \frac{P_2 - P_1}{I_2 - I_1}$$

When the medium is not homogeneous, the resistivity given by the above equation is an apparent resistivity; that is, it is a weighted average of whatever resistivities may exist in the region between the potential surfaces  $P_2$  and  $P_1$ .

As the electrode spacing 'a' is increased, the resistivities of deeper materials affect the measured or apparent resistivity. The method of expanding the electrode configuration systematically about a center point, measuring current and potential differences, and calculating apparent resistivities is called vertical electrical sounding. A plot of apparent resistivity values versus electrode spacing is called a vertical electrical sounding (VES) curve.

Figure 16 shows a VES curve obtained in the north Vermilion County study area along with the layering parameters obtained by the Zohdy Inversion Technique (Zohdy and Bisdorf, 1975). The layer extending from 58 to 105 ft (18 to 32 m)



**Figure 16** Apparent resistivity curve and layering parameters determined by Zohdy Inversion Technique.

below the earth's surface with a "true" resistivity of 418 ohm-ft (127 ohm-m) coincides with a known sandy zone in the drift. The lower resistivity layers above and below correspond to finer-grained materials.

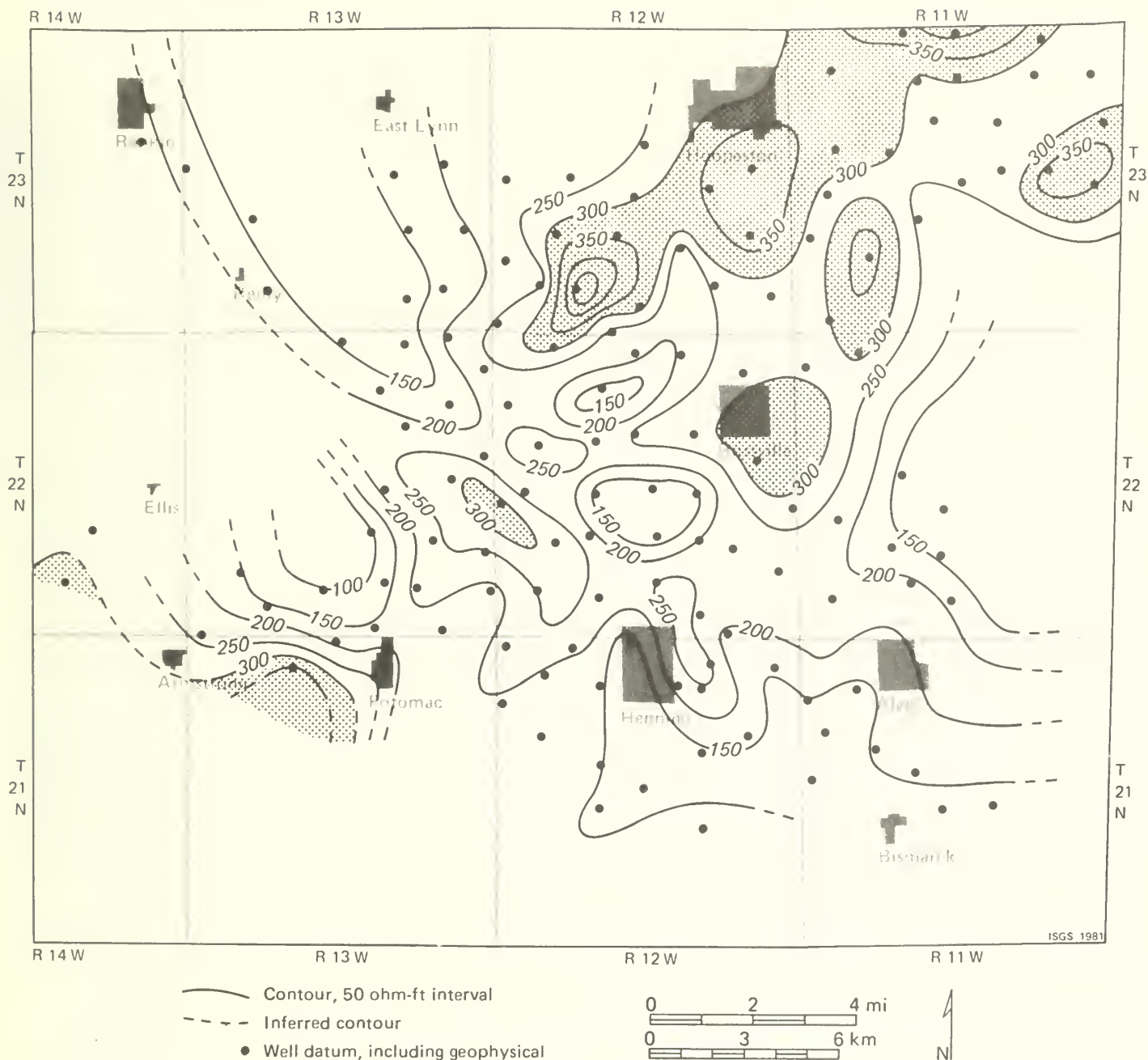
The instrument used in the electrical earth resistivity survey of northern Vermilion County was a Soiltest R-60 Stratameter owned by the Illinois State Geological Survey. This is a direct current instrument with considerably more power than the alternating current meters routinely used by the Survey in exploring for domestic, community, or industrial water supplies. The additional power was necessary because the unconsolidated deposits that cover the study area and contain the aquifers of interest are normally quite thick. For the VES curves to represent apparent resistivities of the entire thickness of the unconsolidated deposits in the study area, Wenner electrode configuration 'a'-spacings as great as 400 ft (122 m) often were used.

Existing geologic data in the study area indicate that there are two large aquifers in the Illinoian and pre-Illinoian glacial drift. As stated earlier, one or possibly both of these aquifers may be hydraulically connected to a system of alluvial-type deposits of Wisconsinan age that are associated with the North and Middle Forks of the Vermilion River.

In an attempt to determine the lateral extent of known aquifers and discover the location of previously unknown water-bearing deposits in the glacial sediments that cover the study area, the electrical earth resistivity data were used. From the layering parameters determined by the inversion of the 141 VES curves, "true" resistivity values in the planes 500 ft and 600 ft (152 m and 183 m) above mean sea level were tabulated, plotted, and contoured. These slice maps are shown in figures 17 and 18. The planes at 500-ft and 600-ft elevations were chosen because the unconsolidated sediments at these elevations in the study area are predominantly pre-Illinoian and Illinoian, respectively. No slice map was prepared for planes at higher elevations where the predominant, unconsolidated deposits are Wisconsinan tills. Surficial alluvial-type deposits are readily discernible from the topographic maps of the area and the Quaternary Deposits of Illinois map compiled by Lineback (1979). The shaded areas on the slice maps (figs. 17 and 18) correspond to areas where "true" resistivity values are equal to or greater than 300 ohm-ft (91 ohm-m). Unconsolidated sediments having "true" resistivity values of these magnitudes are likely to be coarse grained and water yielding (fig. 19). However, coarse-grained unconsolidated, water-yielding sediments are not the only materials with "true" resistivity values equal to or greater than 300 ohm-ft (91 ohm-m). It is likely that in some places on these slice maps the "true" resistivity values equal to or greater than 300 ohm-ft correspond to non-water-bearing bedrock. For these reasons it is imperative that these slice maps be interpreted in conjunction with the known geologic data.

The most useful way to use the "true" resistivity slice maps is to examine them along with maps dealing with those aquifers they are intended to represent. The 500-ft (152-m) slice map (fig. 17) was chosen to represent the Mahomet Sand (fig. 7) and the 600-ft (183-m) slice map (fig. 18) was chosen to represent the Glasford outwash (fig. 9). Since the slice maps depict "true" resistivity values at a constant elevation while these aquifers are known to vary in elevation across the study area, complete agreement between areas of large "true" resistivity values on the slice maps and location of the aquifer should not be expected.





**Figure 17**

Slice map, "true" resistivity at 500-ft elevation. Stippled areas indicate "true" resistivity greater than or equal to 300 ohm-ft.

The main southwest-trending "true" resistivity high on the 500-ft (52-m) slice map (fig. 17) corresponds very well with the thickest portion of the Mahomet Sand (fig. 7b). Resistivity control is not sufficiently detailed in the western part of the study area to provide a comparison there. The three isolated resistivity highs southeast of the main high resistivity area probably reflect bedrock lithologies. Presumably the variations in resistivity values in the thickest parts of the Mahomet Sand reflect variations in aquifer properties. Thus the places to explore for large ground-water supplies would be those areas where the "true" resistivity values are the greatest.

The 600-ft slice map (fig. 18) does not represent the Glasford outwash aquifer (fig. 9) as well as the 500-ft (152-m) slice map represents the Mahomet



Figure 18

Slice map, "true" resistivity at 600-ft elevation. Stippled areas indicate "true" resistivity greater than or equal to 300 ohm-ft.

Sand. This is probably the result of two factors: (1) surficial sand and gravel deposits (Henry Formation), where present, may influence the "true" resistivity values at the 600-ft (183-m) elevation; and (2) the properties of the Glasford aquifer may vary more than the properties of the Mahomet Sand. All the resistivity highs on the 600-ft slice map occur over thicker parts of the aquifer and thus would be prime areas for aquifer testing. A possible exception is the small resistivity high in the east-central part of the area; however, even this site appears to be associated with a branch of the main aquifer.

The electrical earth resistivity survey has provided data to help delineate aquifers in the study area. More importantly, it has provided a basis for selecting well sites to test the aquifer, particularly where geologic data is sparse.

## SUMMARY OF AQUIFER CONDITIONS

To predict aquifer conditions over the study area, the thickness maps of the Mahomet Sand (fig. 7) and the Glasford Formation outwash (fig. 9) were overlaid and areas showing the various cumulative thicknesses of the two units were delineated. Four classes for ground-water development potential were then determined on the basis of the thickness of sand and gravel in each unit (fig. 20). Greater importance was given to the Glasford outwash than to the Mahomet Sand in assigning the classifications, for three reasons: (1) more data, generally more reliable, are available for the Glasford outwash; (2) the Glasford outwash occurs at shallower depths than the Mahomet Sand, making well construction easier and cheaper; (3) some evidence suggests that ponding occurred in the Danville Bedrock Valley during deposition of the Mahomet Sand, resulting in finer-grained sediments with a lower water-yielding ability.

In figure 20 the areas numbered '1' have the best potential for developing moderate to large supplies of ground water. These contain more than 40 ft (12 m) of Glasford outwash and more than 75 ft (23 m) of Mahomet Sand. The areas numbered '2' have a slightly lower potential for developing moderate-to-large supplies of ground water and contain 20 to 40 ft (6 to 12 m) of Glasford outwash and 0 to more than 75 ft of Mahomet Sand. The number '3' areas contain 0 to 20 ft of Glasford outwash, more than 25 ft (8 m) of Mahomet Sand and have good potential for the development of small-to-moderate supplies of ground water. The areas with the lowest potential for ground water development, those in which only a small supply of water may be expected, are marked with the number '4'. These areas contain 0 to 20 ft of Glasford outwash and 0 to 25 feet of Mahomet Sand. The selection of any site for a test well should be based on both the geophysical data as well as on the geologic interpretation.

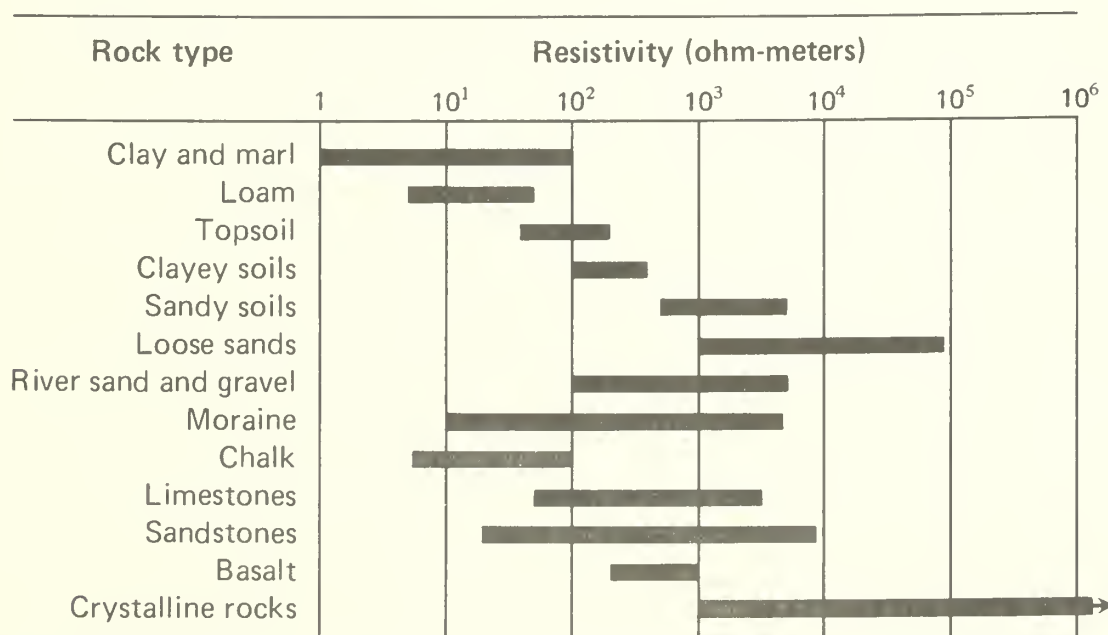
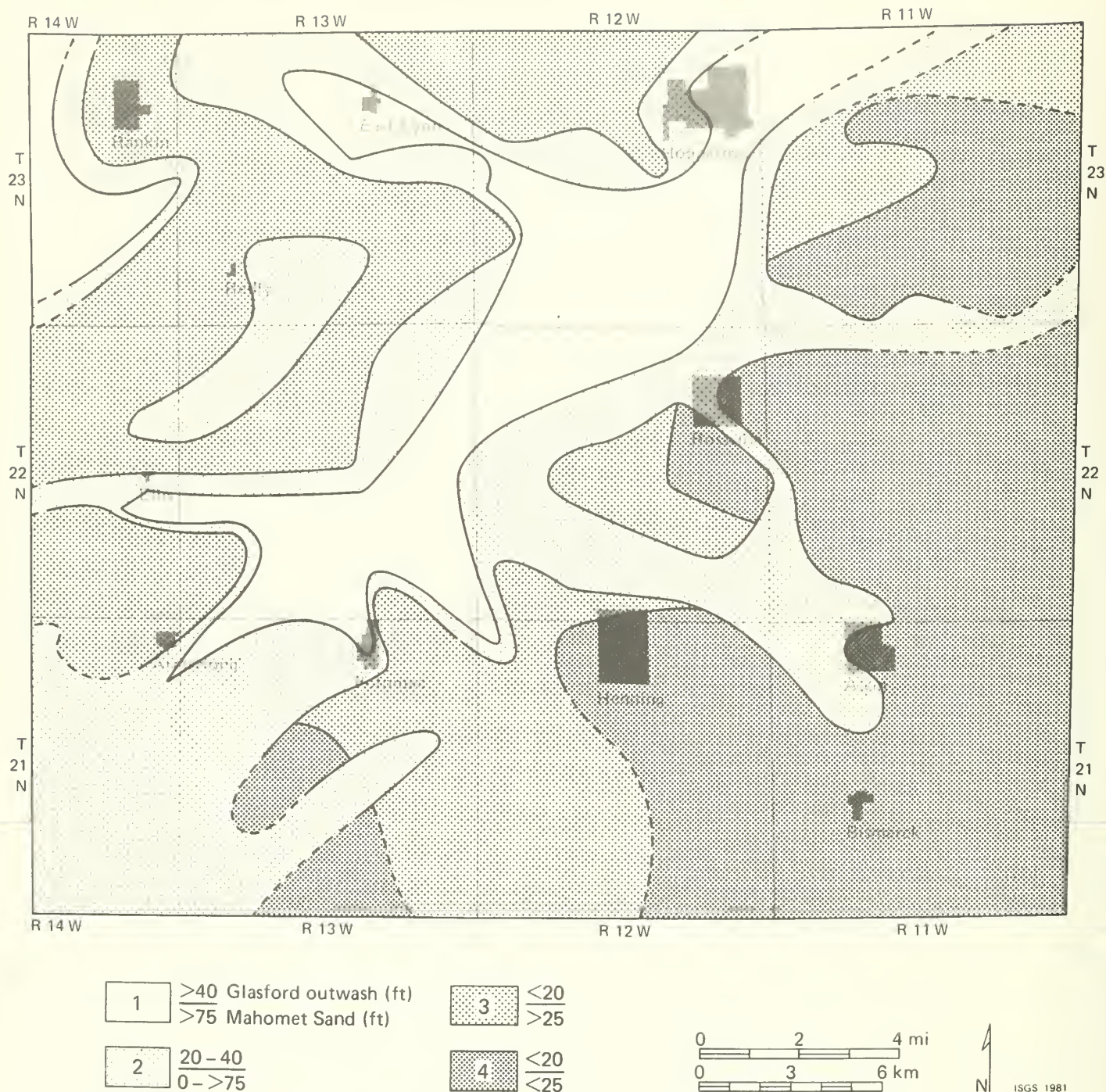


Figure 19

Approximate ranges of electrical resistivity for rocks and soils (from Vingoe, 1972).





**Figure 20** Summary of aquifer conditions in northern Vermilion County.

The most promising areas for ground-water development are in a broad band extending southwest from Hoopeston toward Potomac and smaller areas west of Hoopeston near Rankin and East Lynn (fig. 20). At least a moderate supply of ground water can be expected in most of northern Vermilion County, except for narrow fringes along the southern and eastern edges of the area where both the Glasford Formation outwash and the Mahomet Sand are very thin or absent.

Flowing wells are found within two localities of the study area. The best known are in the Middle Fork Valley around Potomac, where the wells have given Potomac the nickname of the "Artesian City." The second, less well-



known area, is in the North Fork Valley south of Rossville, where several flowing wells are described in well records. Flowing wells result from their position in the ground water flow system, because the hydrostatic head is higher than the ground surface where the wells were drilled. The water is confined by a unit lower in permeability than the aquifer, and when the confining bed is penetrated by a well, the hydrostatic pressure causes the water to flow out of the well bore. Along the Middle and North Forks, where the ground surface is lower than the hydrostatic head, wells can be expected to flow unless heavy pumpage in the area lowers the head in one or both aquifers significantly.

Much of the discussion in this report is based primarily on the interpretation of commercial downhole geophysical data, supported by limited well records and by resistivity data. (This is particularly true of the discussion of the Banner Formation.) Therefore, before any large-scale well field development is planned on the basis of recommendations or results from this study, at least a limited program of test drilling will be necessary to confirm or modify the maps included in this report.

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